POWER PLANT ENGINEERING

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South Meadow Station

HARTFORD ELECTRIC LIGHT CO., ULTIMATE CAPACITY 130,000 KW. AT 11,000 VOLTS. CENTRIFUGAL AUXILIARY PUMPS, INBUILT ECONOMIZERS, WASHED AIR FOR COOLING GENERATORS. CENTRALIZED STATION CONTROL

IN ITS BUSINESS of supplying Hartford and adjacent towns with light and power, the Hartford Electric Light Co. has always been a pioneer in planning for the future and in adopting advanced methods and apparatus. As an example, it was the first public service company to install a steam turbine for generating power, and in its plans for the new South Meadow Station it has shown the same forward-looking spirit.

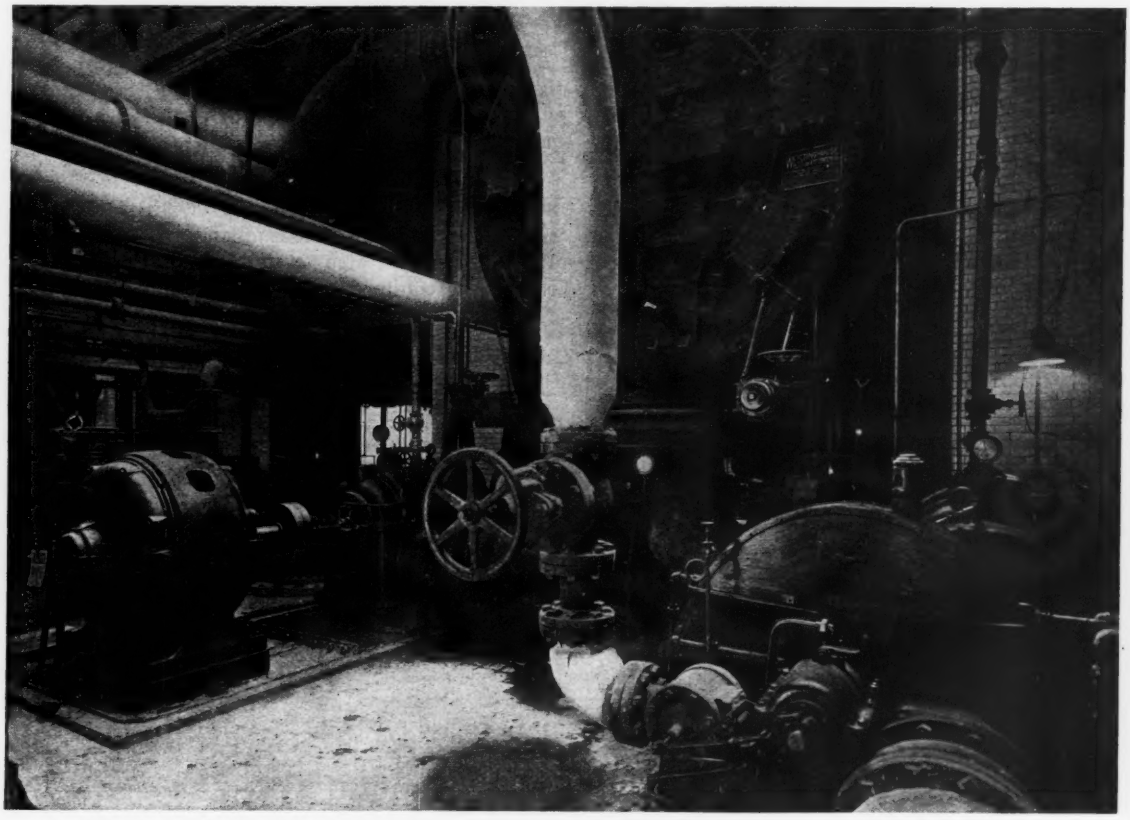


FIG. 16. CIRCULATING PUMPS AND CONDENSER

Hartford, in addition to being an industrial city of considerable size with a corespondingly large demand for industrial power, is situated approximately in the geographic center of a highly industrial state. A central station for supplying its load is, therefore, admirably situated for connection with the network of transmission systems which are gradually being constructed throughout the state and afford a good annual load factor in such stations.

The Dutch Point station has been Hartford's source of current, also being connected by a 66,000-v. line with the Connecticut Power Co., allowing exchange of power as required. But early in 1917 it became evident that the limit of the Dutch Power station would soon be reached, and property was acquired on the Connecticut River about a mile below that station, 50 acres,

meeting admirably all requirements for development of a large steam power station, Fig. 1.

The river gives ample cooling water and excellent boiler feed; railroad and water supply of fuel and machinery is assured; there is plenty of room for expansion, for coal storage and for outdoor high-voltage transformer equipment isolated from casual visits of passers by.

In the spring of 1919 Stone & Webster, Inc., of Boston, were commissioned to proceed with the design of a steam-power station. The design adopted permits five generating units, two of 20,000 kw. and three of 30,000 kw. each, with possibility of still further extension when needed. Construction work was begun in 1920. As a first step, a unit of 20,000 kw. and corresponding equipment was purchased and plans started

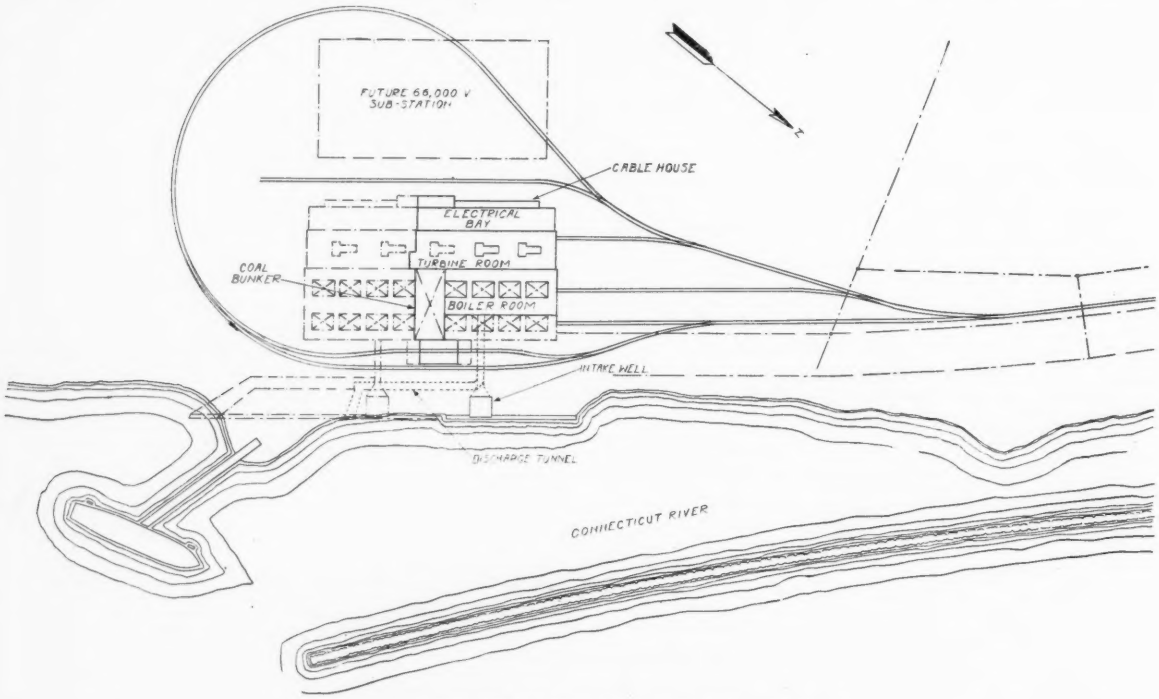


FIG. 1. LOCATION AND LAYOUT OF SOUTH MEADOW PLANT

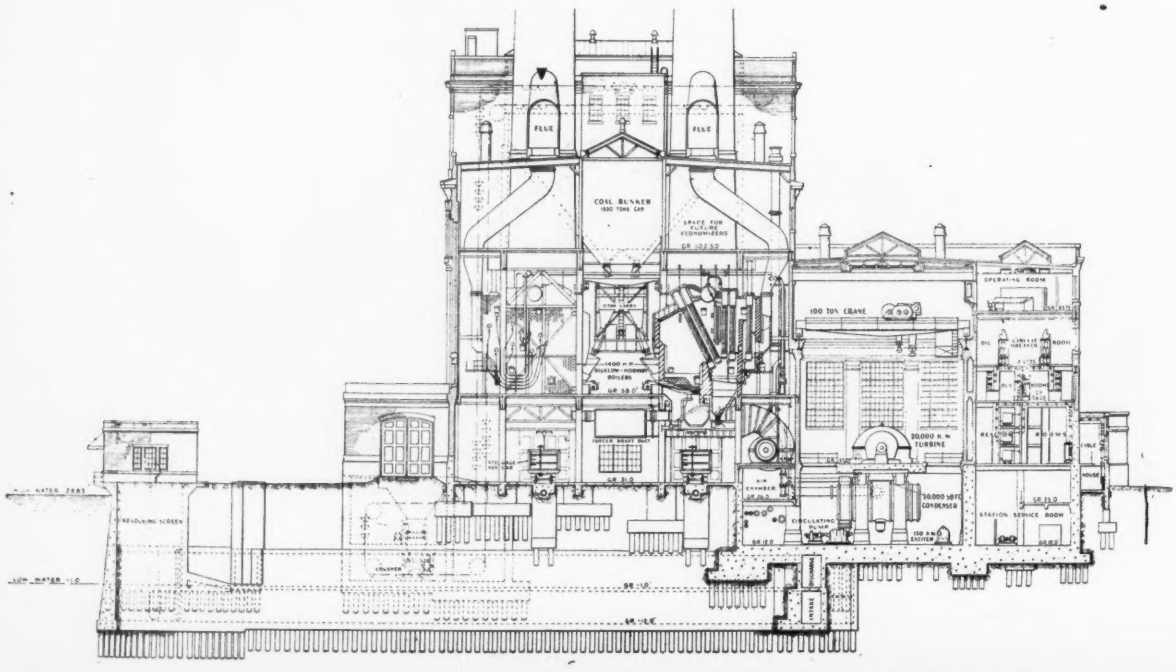


FIG. 2. SECTIONAL ELEVATION THROUGH BOILER AND TURBINE ROOMS AND ELECTRICAL BAY

for buildings and installation, that unit now being ready for service. Somewhat later the second 20,000-kw. unit was ordered, and will be installed in the near future.

General Arrangement

In the working out of the design, simplicity and compactness of arrangement were aimed at, combined with sufficiency of operating space around the units. The design as worked out gives a ground area of but 0.57 sq. ft. and 60 cu. ft. per kw. for the present installation. For the ultimate station these figures will be reduced to 0.54 sq. ft. and 56 cu. ft. per kw.

As shown in Fig. 1, the plant has boiler room, turbine room and electrical bay parallel to each other and to the water front with space at the side for high-tension transformer station and in the rear for station extension and outside coal storage. The present construction covers a little more than half of the main buildings and has a loop track for coal handling which was installed so as to be used during construction. The coal bunker is ample for the contemplated complete station, while track, track hopper and water tunnels can easily be extended when greater capacity is required.

When finished the station as contemplated will have a boiler room 370 ft. by 105 ft., turbine room 362 by 55 ft., and electrical bay 33 ft. wide. Space allowed for the substation is 331 by 168 ft. The building sets back 110 ft. from the water front to allow room for the coal tracks. The ash room floor is at ground level, 31 ft. above datum, so as to avoid high water, as the river at this point rises some 30 ft. at flood, Fig. 2. To obtain condensing water during low-water periods, it was necessary to place the condenser floor 20 ft. below high water and to guard against flood conditions, that part of the turbine room was made a water-tight concrete box, secure against flotation.

At the ash room level are tracks for cars, the forced draft duct, locker room, toilets and the boiler house transformer room, with ash hoppers below the boilers. Directly above are two rows of boilers and stokers, with firing aisle between, while above the boilers a level is provided for possible future separate economizers.

Concrete stacks are carried on steel above the boilers, uptakes going vertically to the connecting flues which are placed on the roof.

The coal bunker section, at the center of the ultimate plant, is carried higher than the boiler room to provide space for the bunker with bucket conveyor above, space below the sloping ends of the bunker being used for surge tanks, feed-water heaters and treating apparatus. Vertical pipe runs for steam, exhaust and water are carried at the landward side of the boiler room in a space which is carried down to condenser floor level to permit ready connection to condensers and auxiliary apparatus.

On the condenser floor level are located practically all pumps, air washers, rheostats, separate exciter, oil and service rooms and toilets, the only operating equipment at turbine floor level, which is really a platform 15 ft. wide between units and with 4 ft. space at each side of the units, being the turbo-generating units themselves. This gives all room needed for operation and allows plenty of light to reach the condenser floor.

All auxiliary equipment is on the boiler room side of the condenser floor, leaving the side next the electrical bay free. This simplifies and shortens piping and gives space for dismantling. A 100-T. crane above the turbine room serves all turbine units and condenser floor equipment.

In the electrical bay on the turbine floor level are the office and first aid room, reactor room, testing and lighting transformers and battery room, and on floors above the bus rooms, oil circuit breaker room and at the top the operating room.

Steam is made at 275 lb. and superheated 225 deg. to 640 deg. F. Current is generated at 11,000-v. and transmitted direct for local distribution and to the Dutch

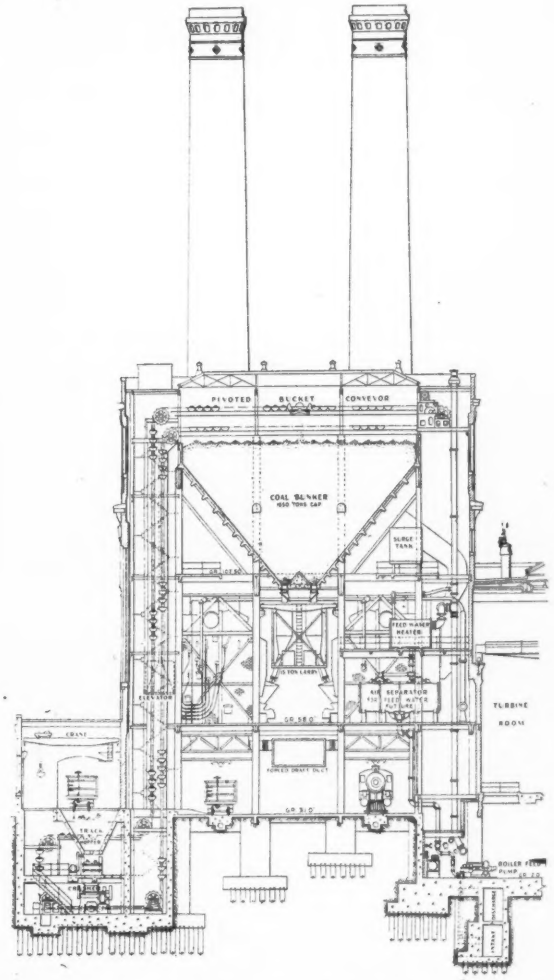


FIG. 3. SECTION SHOWING COAL HANDLING SYSTEM AND FEED WATER SYSTEM

Point tie lines. It is stepped down to 2300 and 220 v. for station use, and put to 66,000 v. for tying in to the Connecticut Power Co.'s lines.

The building is of steel and brick construction, the exterior of red brick with precast concrete trimmings. Concrete is used for foundations and floors, the turbine platform and condenser floor being covered with square red quarry tile and turbine room walls faced with enamel brick of pleasing shade.

Ash hoppers are of concrete, lined with brick, and the track hoppers and coal bunker of reinforced concrete supported on steel beams.

Water Supply

As the river water is of excellent quality, it is to be used for all purposes, although city water line is piped to fill the service tanks in emergency, and also to supply the yard fire service. Water for boiler feed is passed through two 250 g.p.m. sand pressure filters but not purified or deaerated, although space is provided for an evaporation system for make up water, if it ever becomes necessary, also for air removal equipment. The chief sources of boiler feed will be condensate, and water from the clean drain sump which takes returns from bearings and other clean station service, and drip from the high-pressure steam lines. Condensate is pumped through the turbine oil coolers, then through condensers for steam air jets if those are operating, thence to the surge tank, with bypass going direct to the feed-water heaters, Fig. 3. Other water may be discharged either to the 20,000-gal. service tank on the roof, or to the 5000-gal. surge tank located below the coal bunker, as desired.

In the service tank a partition forms two compartments: one for boiler feed and power service, into which only filtered water is led; the other for fire lines and station service which receives unfiltered water. Overflow from the power service compartment is into the house service aside from which an overflow pipe is led, the elevation of dividing partition and overflow pipe being so arranged that the flow cannot reverse. Filtered make-up water is admitted from service to surge tank by a float control, and in the same way from surge tank to feed-water heaters. Overflows from the surge tank, and through water seals from the heaters connect to a common downtake which joins that from the service tank, emptying into the discharge tunnel. Drains from service tank and heaters also connect to these overflow pipes, and a telltale open pipe shows at the condenser room when the heaters are overflowing.

Water flows to the boiler feed pumps under 80 ft. head, normally from feed-water heaters, or in emergencies, bypassing the heaters from the surge tank or by direct line from the service tank. Supply may also be drawn from the intake tunnel. Two open type heaters are used, 12,000 hp. each, supplied with deactivating material and using exhaust from the auxiliaries which will be so operated as to give a temperature of 180 deg. F. to water leaving the heaters. Two three-stage centrifugal pumps, 1000 g.p.m., are used for boiler feed and one four-stage, 500 g.p.m., the discharge passing from a twin connection on each pump to duplicate piping feeding 8-in. main and auxiliary feed headers.

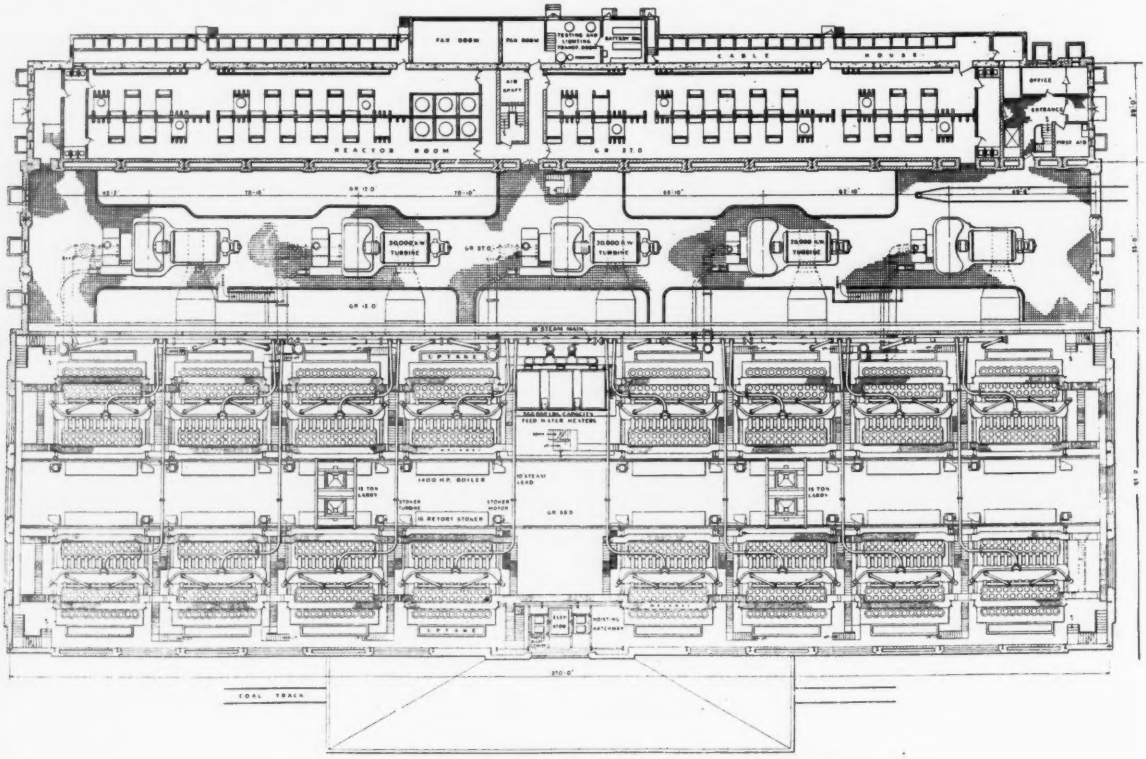


FIG. 4. PLAN OF BOILER ROOM AND TURBINE PLATFORM

From these each boiler has two 4-in. feed connections with Venturi meters and Stets water line regulators controlling flow into the inbuilt economizers at the rear of the boilers. Economizer drums and steel tubes have been painted inside with a rust-resisting compound.

Additional filters, tanks, heater and pumps will be provided as enlargement of the plant requires.

Dirty water flows to a separate sump where it is pumped out and thrown away.

By carefully laying out piping, even of minor size, to get simplicity and least duplication which would insure continuous operation, complexity and expense have been avoided and ease of operation secured.

To supply the fire lines, water may be taken from the service tank, or the two-stage fire pump will draw 1500 g.p.m. from the intake tunnel; check valves prevent the fire pump from forcing back into the service tank, or water from the tank going to the fire pump.

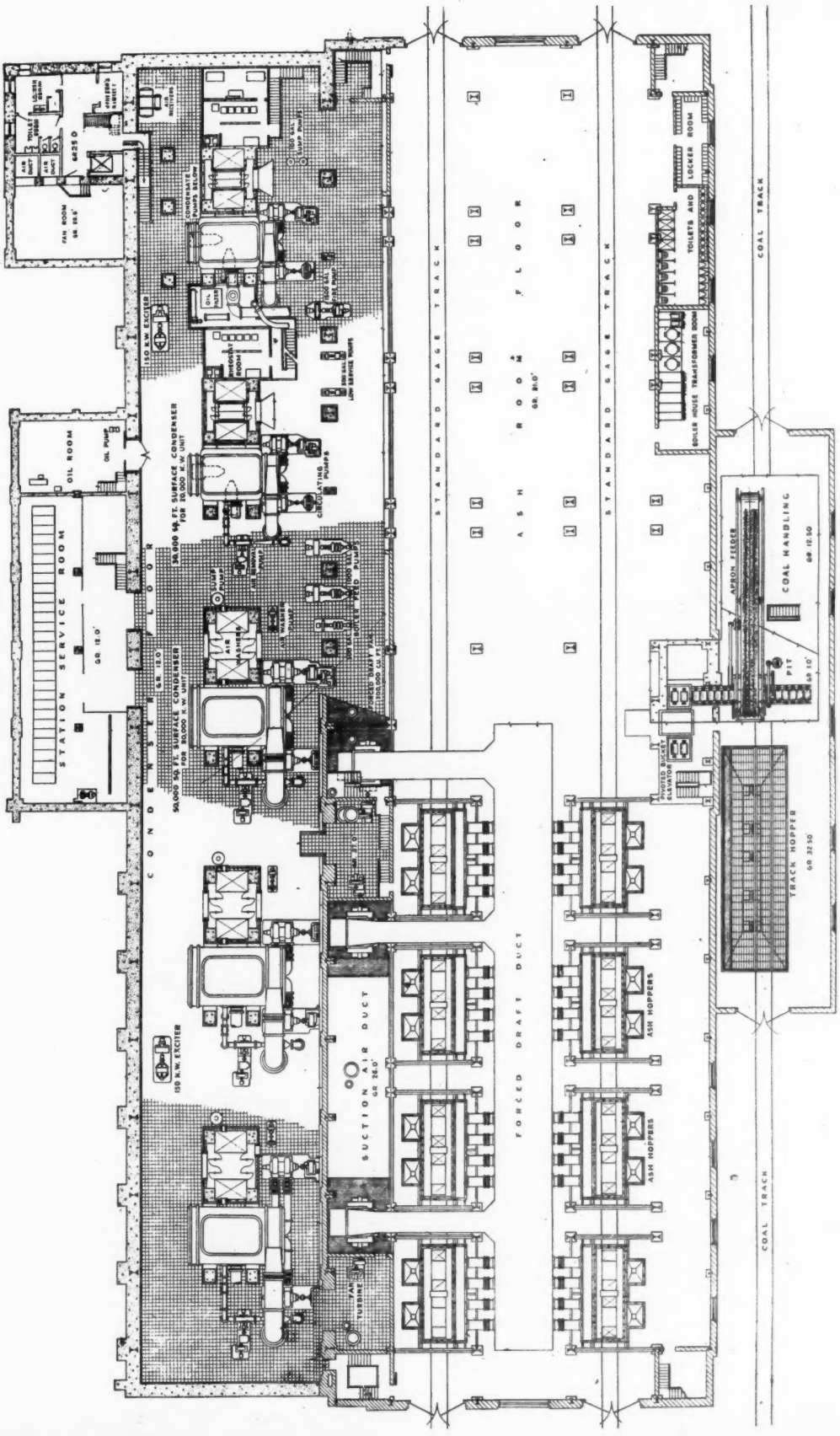


FIG. 5. PLAN OF CONDENSER AND ASH ROOMS

Station service is by gravity, the line being connected direct to the service tank which is supplied by low-service pumps drawing from the intake tunnel. These pumps deliver either direct or through the sand filters, which are so arranged that to clean them, water may be sent through them either direct or reversed and wasted to the service tank overflow.

As seen in Figs. 1 and 2 the 10 by 6-ft. concrete intake tunnel is below low-water level, passing under the boiler room to the condenser room where it connects to a T-head lengthwise of the building. At the inlet is a screen house with gates, racks and traveling screens to catch rubbish. The discharge tunnel, also 10 by 6-ft., is over the intake, but turns and is carried some 190 ft. down stream to an outlet. These tunnels

boiler heating surface. There is also a Foster superheater of 6250 sq. ft. surface located in the second pass, designed to give 225 deg. superheat at 200 per cent rating. Riley multiretort underfeed stokers are installed, extra long and with continuous dump plates from which the ashes fall into hoppers having capacity for 24 hr. accumulation of ashes. These discharge by gravity through 36 by 48-in. ash gates, operated by compressed air, four to each hopper, into standard gage cars spotted on the track below. Soot and ashes are cleaned by a Diamond soot blower from the rear passes, fall into an auxiliary hopper behind the bridge wall and are also discharged by bottom gates into the cars.

Each stoker has 16 retorts giving 286 sq. ft. area and the combustion chamber runs full height of the

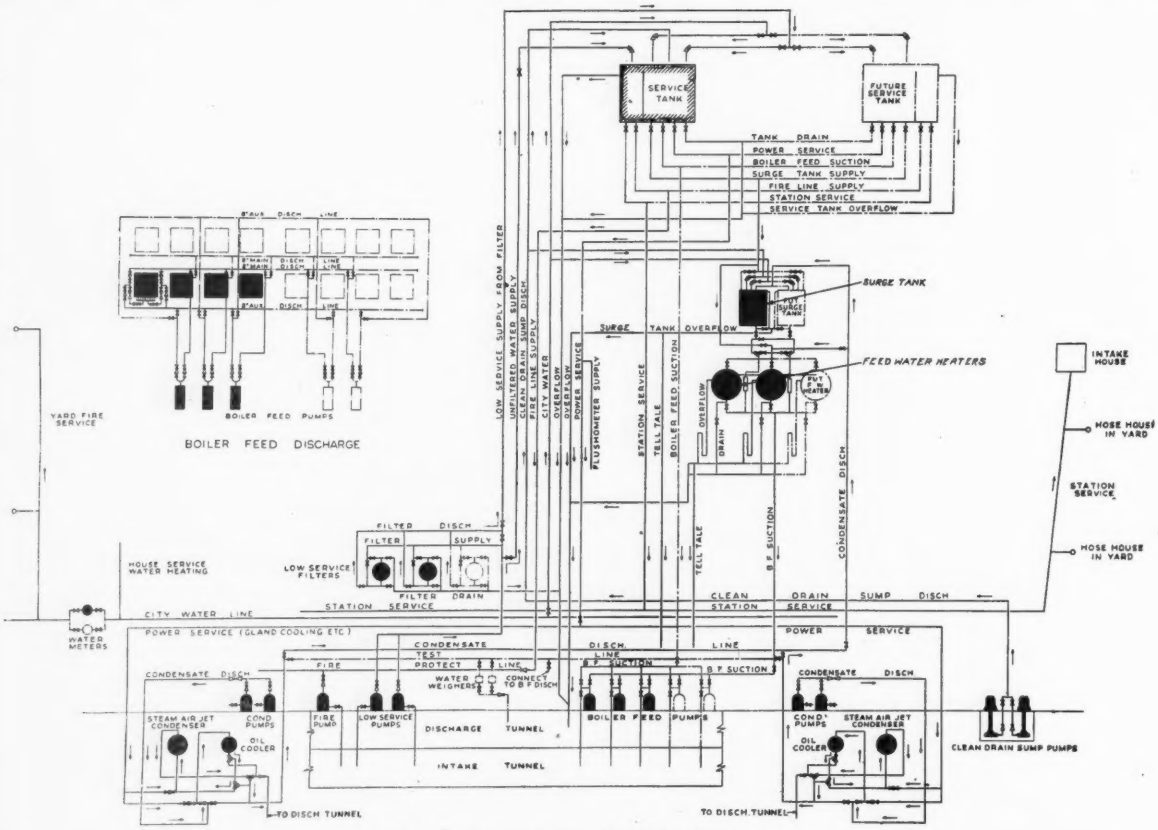


FIG. 6. WATER SYSTEM CONNECTIONS

are sufficient to handle water for 70,000 kw. capacity, and will be extended and an additional intake provided for the ultimate plant as shown in Fig. 1.

Boiler Equipment

Present installation consists of four Bigelow-Hornsby boilers, 1400 hp. (14,000 sq. ft.) each, which is one-fourth the ultimate equipment. Arrangement in a double row with common firing aisle permits a clear space with light and ventilation from an A skylight and allows of coal supply to the stokers of both rows from a single 15-T. larry loading from the coal bunker. No boilers are placed under the bunker which leaves space there for water heating, coal handling, elevators, etc.

Each boiler has an economizer inbuilt at the rear of the setting with heating surface 20 per cent of the boiler, giving 6370 cu. ft. of volume or 22.2 cu. ft. per square foot of grate.

Geared to one end of each stoker drive is a steam turbine, and to the other end a four-speed induction motor. The turbine has automatic regulation to vary the speed according to steam demand, while the motor is hand controlled for six operating speeds.

Boiler settings are of first and second quality fire brick, common brick being used only on the outside of economizer walls. Bridge walls are faced 24 in. high with carborundum brick opposite the dump plates to resist abrasion by clinkers, and side walls have the Bernitz system of ventilation to prevent clinker formation. Around the side walls a steel wainscot 6 ft. high is placed to protect the outer brickwork.

Air for combustion is supplied by a forced draft

duct under the boiler room floor, each boiler having four inlets from the duct. Two turbovane fans (ultimately six), 200,000 cu. ft. per min. each, supplying air to the duct, are located near the wall of the turbine room in the forced draft supply chamber. They are gear driven by steam turbines located outside the chamber in a recess of the turbine room. Air is drawn from the boiler room and outdoors. Dampers are provided at each fan in each wind box connection and in the forced-draft duct at every fourth boiler.

Uptake dampers for each boiler are operated by "Balanced draft" regulators to maintain a slight minus pressure in the furnace. Speed of the fans is controlled by regulating valves in the steam lines to driving turbines, these valves being actuated by master steam pressure controllers governed by pressure in the main header. These controllers also similarly regulate the speed of the stoker-drive turbines, so that fuel feed, air pressure and air supply are varied together according to steam demands.

One stack, 15 ft. 6 in. by 215 ft. above grates serves four boilers. It is of concrete on steel above the boiler level. Uptakes from the boilers lead directly upward and there enter the horizontal flues which are carried on the roof and uninsulated. If future rising coal costs warrant the use of separate economizers, induced draft will be necessary at high boiler loads and space has been provided for the fans.

Coal Supply

For the present, coal will come to the plant by rail and can be delivered to receiving track hoppers or to an unloading trestle from which a locomotive crane transfers to storage pile; the crane, standard gage cars and an industrial locomotive are the means for reclaiming the stored coal. This forms a simple and inexpensive arrangement for coal handling and was also used to advantage during construction of the plant. If, in the future, large delivery of coal is advisable, there is room at the waterfront side for a tower and unloader.

Coal for delivery to the station is dumped into track hoppers covered by a low house. Two cars can now be dumped at a time; the completed outfit will take four cars at once in two hoppers, each of 140 T. an hour capacity. Below each hopper is an apron conveyor 60 in. wide to carry the coal to two 36 by 48-in. double-roll crushers, each of which can handle 130 T. an hour. Chutes and bypasses permit discharge from either conveyor to either crusher, also from either crusher to either of two bucket elevator conveyors with 30 by 36-in. malleable iron buckets, capacity 130 T. an hour at 45 ft. per min. These elevators deliver the coal to the central bunker. Drives of conveyors, crushers and elevators are by induction motors with controls so interlocked that starting and stopping can be done only in the proper sequence. Half the ultimate installation is now installed.

The central bunker is carried overhead on steel beams, with sloping sides of reinforced concrete, heavily ribbed, and has a capacity of 1850 T.

From the bunker a 15-T. larry measures and delivers coal to the stoker hoppers on either side of the firing aisle, so that neither coal nor ashes are moved by hand at any point in the plant.

Boiler Room Control

In a room designed for the purpose and located in the center of the ultimate plant, boiler and combustion control equipment is placed. This comprises the master controllers for stokers and fans already described, a gage board on which are most of the boiler room instruments such as indicating pressure gage, recording gage for steam, feed and draft pressures, recording thermometers for steam, feed and flue gas, steam flow meters, CO_2 recorder and a totalizing wattmeter for plant output. This arrangement permits one skilled boiler room operator to observe and control output and efficiency of the entire room.

While operation will normally be automatic, if conditions make it desirable, the boilers can be controlled manually, and at each boiler is a steam gage, flow meter and three-in-one draft gage for the guidance of the attendant. While it is not expected that centralized

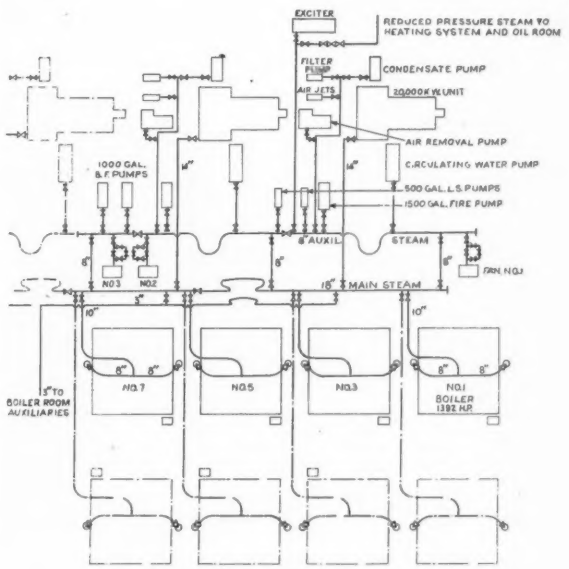


FIG. 7. STEAM PIPING CONNECTION

control will give perfect combustion at all times, it will enable one competent man to correlate operation, which will work for plant efficiency.

Choice of steam and motor driven auxiliaries will be made so as to give exhaust to heat the boiler feed to 180 to 212 deg. as it enters the economizer, but if light load conditions require that steam auxiliaries be used to give more exhaust than needed, the excess will be automatically bled into a low-pressure stage of the main turbine. The temperature 180 deg. was chosen, having in mind loss of efficiency through economizer sections if the temperature went higher, and the possibility of corrosion troubles from condensed flue gas moisture if it went much lower.

Steam Supply

All piping has been laid out to secure the greatest simplicity and least duplication, headers being arranged symmetrically with ample room for access. The main piping has cast-steel fittings and valves, rolled steel Van Stone flanges on the pipe and all flanges of "Sargol" welded type. To reduce the number of joints, welded

nozzles of the interlocking type and line welds of telescope type were used.

On each boiler an 8-in. outlet leads from each side of the superheater to a 10-in. line which runs horizontally to near the turbine room wall, then turns down into a main header mounted on stands 4 ft. above the boiler room floor, Fig. 2. This header is 18 in. outside diameter, with expansion bend and sectionalizing valve every four boilers. From each section a 14-in. lead is taken off to a 20,000-kw. turbine and like arrangement will be followed for later units.

Eight-inch connections lead from the main header to an 8-in. auxiliary header under the forced draft air chamber at the side of the condenser floor, and from this supply lines are taken to pump, fan, and exciter turbines, to jet air exhausters at the condensers and through a reducing valve to the heating system and oil room. The header is divided into sections, one for each generating unit, with expansion bends between, and each section connected to the main header; but auxiliaries for general service such as boiler feed pumps are not all connected to the same section of the auxiliary header so that any

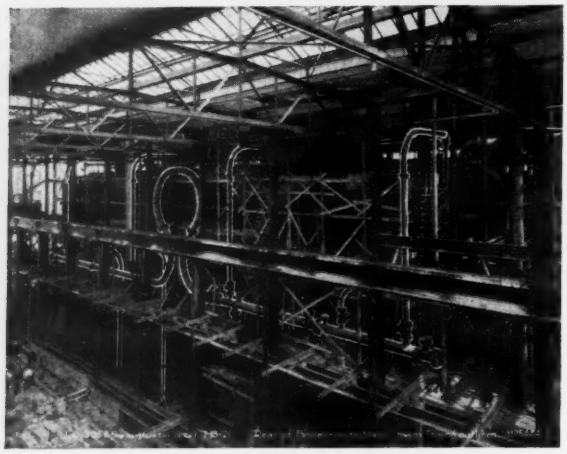


FIG. 8. MAIN STEAM PIPING DURING CONSTRUCTION

section may be cut out without interfering with operation of the station. Connecting lines between headers and supply lines to auxiliaries have valves at each end so that the line may be isolated to prevent condensation when idle and to permit of repairs.

Exhaust from auxiliaries goes to a single exhaust header with 20-in. riser to the feed heater, joints in the larger sizes of piping being by Van Stone flanges. A separate exhaust header and riser will be installed for the future auxiliaries.

To supply steam in the boiler room for soot blowers, stoker turbines, etc., a 3-in. header is provided having several connections to the main header and expansion bends as needed, but not divided into sections.

Ample provision has been made for draining the system, a Holly return loop being used to return drip water to the heaters; in addition, a flooding receiver and trap are placed under the Holly receiver so that unusual amounts of water will overflow and be returned direct to the heaters without flooding the Holly system.

One of the features which simplifies smaller piping and operation is the air exhausting for priming pumps. For each main unit there is a pair of 3-in. exhausters, only air piping being run to each pump, which gives quick priming of any pump to be started and a minimum of attendance for the system.

Turbine Equipment

Two 20,000-kw. turbo-generator units, one now installed, the other to follow in 1922, constitute the first stage of development. These are General Electric Co. machines, 23-stage, giving a water rate at best loading of 10.1 lb. steam per kw.-hr. and are carried on reinforced concrete foundations which are isolated from the building structure.

Bolted direct to the exhaust nozzle of each turbine and supported on springs below is a Westinghouse condenser with 30,000 sq. ft. cooling surface. The supporting springs were carefully calibrated and adjusted for weight of condenser light and loaded, condenser expansion, and the resulting spring load. Auxiliaries to operate the condenser are provided in duplicate as follows: two 18,000 g.p.m., bottom-suction circulating water pumps with motor-operated valves on the outlet pipes, one gear-driven by a steam turbine, the other direct-driven by an induction motor. Either pump will handle sufficient cooling water to give economical vacuum during most of the year. Two two-stage, double suction condensate pumps, direct connected, one to a turbine, the other to a motor; either able to carry the entire load of the condenser. For normal air exhaust, a Le Blanc hydraulic air pump, gear-driven by a turbine; and as alternative a two-jet, single-stage air exhauster discharging into a small surface condenser which is cooled by condensate or by service water. To permit emergency operation of the main turbine non-condensing, a 30-in. outboard exhaust is carried across the condenser room and up through the boiler room roof.

Generators

These are direct driven by the main turbines, delivering three-phase current at 11,000 v. and are star connected with the neutral carried to a ground bus through an oil circuit breaker.

Connection from the bus to ground is through a 5-ohm resistance of 1300 amp. capacity for 1 min., but this resistance can be short-circuited in order to furnish more current to burn out a ground on a cable. Normally only one generator will be connected to the bus.

Each generator carries on the end of its shaft a 250-v. exciter of capacity to furnish exciting current for that generator and a 150-kw. turbine-driven exciter is installed as relay large enough to excite one of the 30,000-kw. generators. Another relay exciter will be installed when the plant is completed. Normally each 100-kw. exciter will serve its own generator, but provision is made for transferring exciter connections without interrupting service.

For cooling the generators a closed recirculating system is used, 55,000 cu. ft. of air per min. being required for each generator. This is cooled at each passage by water sprays as shown in Fig. 9, the spray chamber, baffles, pumps and damper control being directly below the generator where the 25 ft. from turbine base to condenser floor gives ample room. The

(Continued on page 1210)

Superpower Survey

OUTLINE OF SCHEME TO CONNECT ALL IMPORTANT ELECTRIC UTILITY PLANTS BETWEEN BOSTON AND WASHINGTON; PROPOSED DEVELOPMENTS OF LARGE STEAM AND HYDROELECTRIC PLANTS; ESTIMATED COSTS AND SAVINGS

UNDOUBTEDLY the most important investigation ever carried on, affecting directly the power industry of this country, is the Superpower Survey, the findings of which have just been published by the Department of Interior. This work started on July 1, 1920, and was completed on June 30, 1921, under the direction of W. S. Murray with whom were associated nearly 200 engineers and other eminent specialists whose knowledge of the field was needed in bringing the data together in a comprehensive form.

"The superpower system is nothing more than a superutility," explains Mr. Murray in the introduction, and "should be visualized as one great power project serving the superpower zone." Energy developed in the various plants now in operation and those to be built will be used by the electric utilities, industries and railroads; the total estimated requirements within the territory surveyed will amount to 31,000,000,000 kw.-hr. in 1930. The estimated annual cost of this power would be $239,000,000 less than by an un-coordinated system. Investment in generating and transmission facilities for this system will be $1,109,564,000, of which $416,346,000 represents the value of existing facilities.

Regarding the 96,000 manufacturing establishments studied, it is stated that by 1930 by the use of purchased power an annual saving can be made of $190,000,000. Capital investment necessary for the electric utilities and the industries as of 1930 amounts to $1,294,564,000, which will yield 33 per cent annually.

Of the 36,000 mi. of railroads in this zone, 19,000 mi. can be profitably electrified so as to yield by 1930 an annual saving of $81,000,000 as compared with cost of operation by steam. The primary capital expenditure would be $570,000,000 and the return on the investment would be 14.2 per cent annually.

As defined in the report, the superpower system begins at the generating stations connected to its lines and ends at the busses of the existing utilities. The estimated coal saving as of 1930 due to the superpower system is, by electric utilities, 19,149,000 T., heavy-traction railroads 19,210,000 T., and manufacturing industries 20,625,000 T., or a total of 49,984,000 T.

It is believed that the quickest return will be obtained by following in chronological sequence the order of procedure given below:

1. The construction of a steam-electric plant at Pittston, Pa., to supply part of its energy to the anthracite division of the superpower zone and the remainder to the metropolitan division, particularly New Jersey.

2. The construction of a steam-electric plant near Sunbury, Pa., to supply part of its energy to the anthracite division, a part to the Reading load center, and the remainder to Philadelphia.

3. The construction of hydroelectric plants on the Delaware and Susquehanna rivers to supplement the steam plants indicated in paragraphs 1 and 2.

4. The progressive development of the Hudson River projects to meet the growth of energy requirement at the Schenectady, Utica, Poughkeepsie and Pittsfield load centers.

5. The construction of a steam-electric plant near Boston to supply the Boston, Lowell, and Newberry port load centers.

6. The construction of a steam-electric plant near New Haven to supply the New Haven, Bridgeport, Waterbury and Norwich load centers.

7. The partial construction of the first hydroelectric plant in the development of the Potomac River as soon as the power demands for the Baltimore and Washington load centers require additional plant capacity.

Within the zone covered by this survey are operated 315 electric utilities, 18 railroads and 96,000 industrial plants, and the system recommended comprehends a plan of power production that includes the generation of electricity by steam at tidewater and on inland waters where sufficient quantity for condensing water can be obtained, and also the utilization of all hydroelectric power that may be economically obtained from rivers within the zone or within transmission distance of it. The electric power so generated will be co-ordinated through a system of interconnecting transmission lines, the potentials of which will be on the order of 220,000 and 110,000 v.

In the illustration is shown how the superpower system should appear in 1925 and in 1930. The number of load centers in 1919 were 20 while the survey shows that by 1930 there will be 34.

ELECTRIC UTILITY DATA

OF THE 558 electric utility plants in the zone, the average capacity is 7900 kw., the steam plants averaging 10,000 kw. and the hydroelectric 2800 kw. The average capacity of the isolated industrial plants is 350 hp. Under the proposed system, by 1930, the number of power stations required to supply the entire zone will be only 273 of which 218 will belong to the existing electric utilities. The capacity of the base-load steam plants will range from 60,000 to 360,000 kw. In none of these will there be installed a turbo generator having a capacity less than 30,000 kw.

This system does not seek to supplant or even to compete with the existing electric utilities and can be urged only as it shall carry to a higher degree the services and economies incident to their present operation.

Briefly stated, the problem set for the engineering staff was that of determining the total amount and location of the power load that would be required for municipal, private, industrial and railroad purposes at a date sufficiently in advance to permit the construction of a system of the highest economy to supply it. The date chosen was 1930. This work was done through the co-operation of the electric utilities, the railroads, and the industries within the zone.

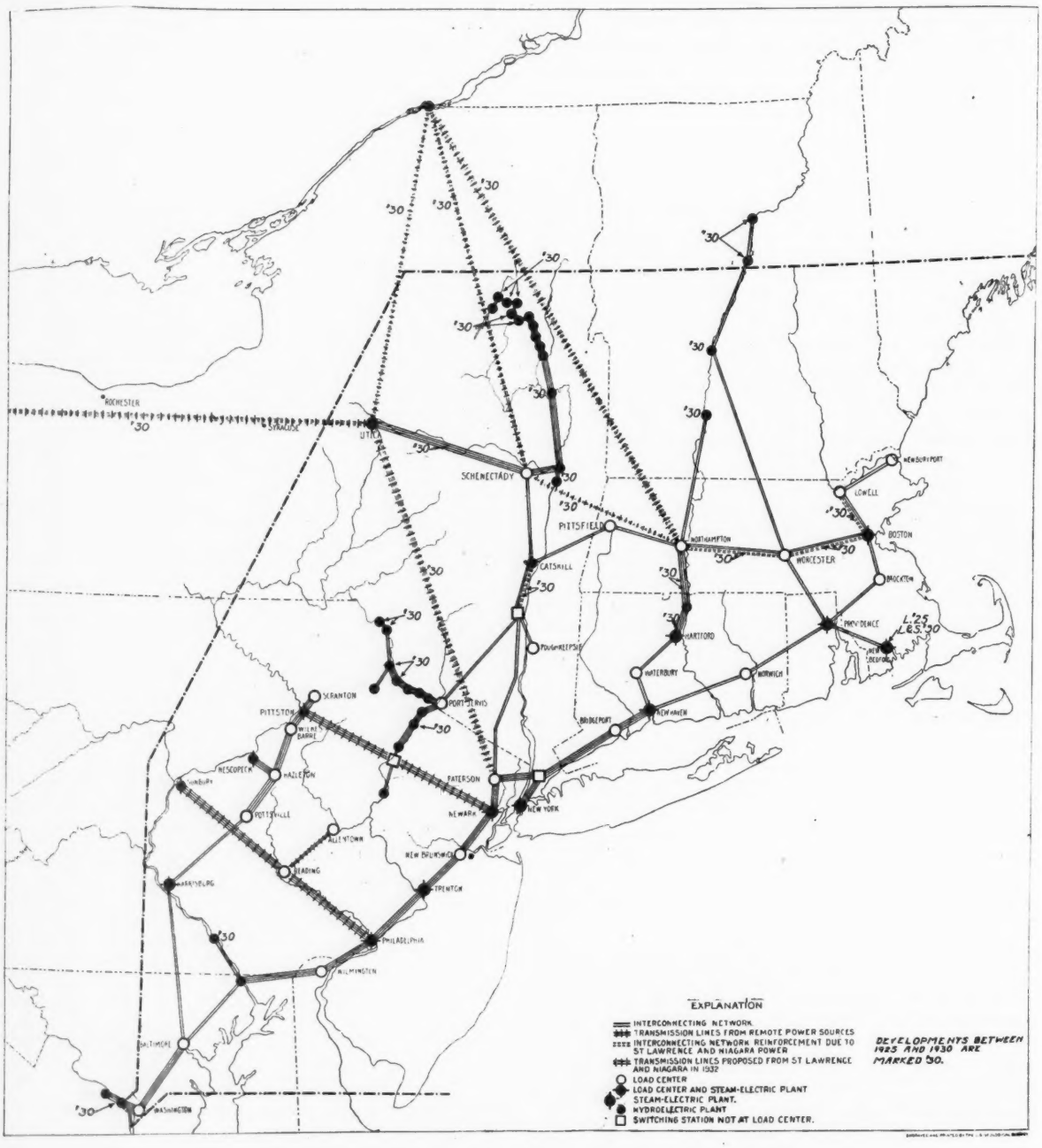
Out of 558 electric utility plants there are but 36 whose capacity equals or exceeds the average capacity of the plants of the superpower system in 1930, and of the 1074 generating units of 500 kw. or more operating within the zone in 1919 only about 20 had a capacity greater than 30,000 kw.

The fuel rate in the average steam-electric utility plant in 1919 was 2.73 lb. per kw.-hr. and a heat requirement of 35,800 B.t.u. per kw.-hr. The estimated fuel rate for the base-load steam-electric plants of the superpower system is 1.41 lb. per kw.-hr., and a heat requirement of 18,300 B.t.u. per kw.-hr.

Under independent operation, the reproduction cost of steam and hydroelectric plants as of 1919 is $156 per kilowatt of capacity corresponding to $125 under superpower generation. In 1919, the average unit production cost was 1.93c. per kilowatt-hour, that with steam was 2.12c. and with hydroelectric power 0.94c. In the steam-electric base-load plants of the superpower system, the unit cost will be 0.99c. per kilowatt-hour.

Industrial Plants in Superpower Zone

It is estimated that, had the superpower system been in operation in 1919, it could have saved the industries of the zone 13,502,100 T. of coal. The industries analyzed included manufacturing establishments, laundries, mines and quarries, and Government manufacturing institutions; these totaled 96,000, of which 76,000 use power. Much of the data upon which estimates were made were secured from the Bureau of Census.



TRANSMISSION SYSTEM FOR SUPERPOWER SYSTEM, 1925 AND 1930

In 1919, 9,311,440,000 kw.-hr. was developed by prime movers operated by the industries themselves and 3,338,800,000 kw.-hr. was purchased. The survey indicates that it would have been economical to shut down 4,008,200 hp. of prime movers and purchase energy to the amount of 5,623,800,000 kw.-hr., making a total of 8,962,600,000 kw.-hr., which would have been purchased in 1919. In making this analysis, care was taken not to invade the field of what might be termed byproduct power.

In general, it was found that establishments requiring less than 500 hp. can economically purchase energy. Only those that need more than 500 hp. and that have special requirements for heat can generate their own power economically.

Performance and Cost

Of the electric utility plants in operation in 1919, the total capacity to be retained is 2,677,000 kw., which is 79 per cent of the effective capacity of the steam-electric public utilities. The reproduction cost of these is $329,219,000. The plants to be retained show an average fuel consumption of 2.15 lb. per kw.-hr. and the average size in 44,600 kw. The reproduction of the plants as of 1919 is $124 per kilowatt as against $109.50 in 1930 for new steam plants. The following operating characteristics for base-load steam plants were determined: Steam pressure at turbine throttle 300 lb. per sq. in.; superheat, 230 deg. F.; final temperature, 652 deg. F.; absolute pressure at turbine exhaust nozzle, 1 in. of mercury.

By 1930, the new steam-electric plants should operate at a capacity factor of about 62 per cent with a fuel rate of 1.43 lb. of coal per kw.-hr. and they have been so located as to obtain the fullest advantage of low freight rates, easy coal-delivery routes, and ample condensing water. Fourteen new steam-electric plants, aggregating 2,520,000 kw., will be required by 1925 and four additional plants or eighteen in all aggregating 3,930,000 kw. by 1930.

Hydroelectric Plants

With maximum development of water power the hydroelectric energy available within the superpower zone will amount to less than 21 per cent of the total electric power required in 1930. It is proposed to utilize power from the following rivers to the extent designated:

River	Capacity kw.	Output (millions of kw.-hr.)	Investment	Production Cost (mills per kw.hr.)
Potomac	200,000	950	$22,000,000	3.36
Susquehanna .	185,000	1,230	28,000,000	3.22
Delaware	350,000	1,250	51,500,000	5.95
Hudson	150,000	900	38,350,000	5.84
Connecticut ..	165,000	760	29,000,000	5.45

The water power of Niagara and St. Lawrence rivers are within transmission distance, but have not been considered available in the zone prior to 1930 owing to the necessary time for development and litigation.

Transmission System

Relative to the transmission and distribution system, it is proposed that "The primaries of today will be the secondaries of tomorrow." The transmission features of the superpower system will have to do only with the transmission of power from the new plants to load centers and to the busses of the existing electric-utility plants. By 1930, this system should consist of 970 mi. of 220,000-v. lines on 4696 mi. of 110,000-v. interconnecting lines. To these lines will be connected 5,600,000-kv.a. transformer capacity not including the transformer capacity in the base-load steam-electric plants. The Niagara and St. Lawrence developments will add 3140 mi. of 220,000-v. lines and 1,824,000 kv.a. of transformers.

In making estimates as to cost of power and other calculations involving the cost of bituminous coal, this has been taken as $2.90 per short ton at the mine. For buckwheat coal used in stations in the anthracite region, $1.75 per long ton has been taken as the price at the mine with $1 per ton for gathering charge. Six months' coal storage capacity at each plant is recommended.

It is stated that the greatest promise regarding process fuel lies in the direction of devising plants that will convert raw fuel entirely into gas for consumption under boilers at steam-electric stations and thus eliminate the enormous concentration of coke. Such a process plant used in connection with a steam-electric plant may produce fuel at a cost materially lower than that of raw coal, but the experimental work done is not yet sufficient to permit a stronger statement than that the progress made is exceedingly encouraging.

The data given here has been taken from the summary of the report written by Mr. Murray and covers in a very brief manner only those features which are of greatest interest to power plant engineers.

Grand Opera Transmitted by Radio Telephone

GRAND OPERA transmitted over an area of 750,000 square miles by radio telephone is the feature initiated by the Westinghouse Electric and Manufacturing Co. in establishing its fourth Radio Broadcasting Station on the Edison Building, Chicago, Ill. This feature, arranged by George Foster, of the Commonwealth Edison Co., with Mary Garden, general director of the Chicago Opera Co., allows thousands of persons throughout the central part of the country to enjoy the benefits of the opera. Small transmitters at the Auditorium Theater pick up the singing of the artists and music of the orchestra. These transmitters are connected through a telephone line to the radio station, where the sound waves are sent broadcast, on a 360-meter wave length, without relaying. The first regular opera to be broadcasted was "Samson and Delilah," the wonderful solos and striking storm effects being reproduced perfectly. It is planned to broadcast opera every night during the season of the Chicago Opera Company. In addition news service will be given from the station similar to those broadcasted from the Westinghouse stations at Springfield, Mass., at Newark, N. J., and East Pittsburgh, Pa. Radio operators from Texas, North Carolina, Vermont, Canada, Minnesota, and many other places report that they are hearing the opera distinctly.

Most fellows you owe know that it's the best policy to be friendly, but forced friendship is poor solace to the honest man who is broke.

Steam Condensing Plants*

PRINCIPAL FIXED AND OPERATING CHARGES ON SURFACE CONDENSER PLANTS. BY PAUL BANCEL

IF COAL cost nothing, it would pay to operate with high vacuum, because the decrease in steam consumption would reduce the bulk and cost of the boiler plant by a greater amount than the added outlay for the condensing plant—Fig. 1. The most important aspect of the condensing plant is in its relation to boiler room costs. Similarly when surface condensers are used, their choice may be said to rest largely on their influence in reducing boiler room charges. With pure feed water, there is less fuel loss and boiler maintenance charges, and what is of still greater importance, boilers may be driven at higher ratings with consequent further reductions in first costs and fixed charges. As indicated in Fig. 1, it would pay to run condensing if coal cost nothing, and pay even more so, if the boiler feed were poor or expensive, to install the costliest of condensers—the surface type.

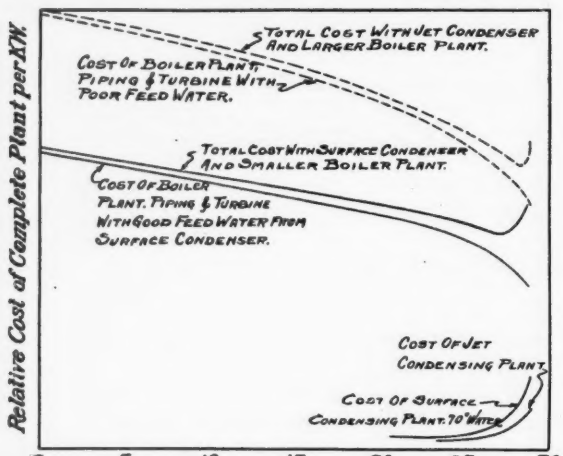

Relative Cost of Complete Plant per KW
Total Cost With Jet Condenser And Larger Boiler Plant.
Cost Of Boiler Plant, Piping & Turbine With Poor Feed Water.
Total Cost With Surface Condenser And Smaller Boiler Plant.
Cost Of Boiler Plant, Piping & Turbine With Good Feed Water From Surface Condenser.
Cost Of Jet Condensing Plant
Cost Of Surface Condensing Plant, 70° Water
0
5
10
15
20
25
30
Vacuum

FIG. 1. RELATIVE FIRST COST OF STEAM POWER AT DIFFERENT VACUUMS

About a year ago, the author visited one of the most celebrated power stations in the country; the vacuum on a number of large turbines was between 27 and 28 in. whereas it should have been an inch higher, and could readily have been maintained at that height had jet condensers been installed instead of the surface type. Many similar instances can be cited of surface condensing plants, which, while generously proportioned, lose so heavily in efficiency due to fouling of the tubes, that their selection would seem to have been a miscarriage of engineering judgment. The vindication is found in the boiler plant.

On the other hand, there are cases where the troubles with surface condensers are so serious as to prohibit their installation entirely. In one instance, the tube life is only a few months and even though boiler tube explosions, cleaning and repairs are a constant source of trouble and loss, jet condensers have been installed on all new units. In another plant, a surface condenser scaled so rapidly from spray pond water that it has been replaced by a jet type.

The designer of a power house is thus in a quandary —flying from boiler evils to condenser evils, and often with hesitancy as to which are the less serious. The problem is one of balancing fixed and operating charges in the boiler room against similar charges in the condensing plant.

FIXED CHARGES

FIXED CHARGES on a surface condensing plant depend in the first place on its size. This in turn depends on the desired vacuum. With coal costing nothing the best vacuum is in the neighborhood of 26 or 27 in., but with actual conditions of coal costs higher vacuum is plainly warranted. The most economical vacuum depends on the fixed charges, the cycle of yearly water temperatures, the cost of coal, the load factor, and the design of the turbine. In Fig. 2, the curve 0-0-0 shows the absolute back pressures at the turbine exhaust which might be expected from a cycle of water temperatures and a certain investment in condenser. The most economical vacuum for a given turbine may be represented by line X-Y in Fig. 2, and the areas A A show excessive vacuum (very low absolute pressures) pressures which represent waste of fixed charges and increased operating charges due to low temperature of condensate. The location of the line X-Y, that is the particular vacuum which it does not pay to exceed, varies with the size of the turbine and the load.

The area above the line and below the curve in Fig. 2 shows the loss of desirable vacuum in the summer due to the high temperature of the cooling water.

The fixed charges on a surface condensing plant must also include an annual charge to cover retubing at the end of the life of the tubes. In one plant the tube life might be 5 yr., and in others a great deal more or a great deal less. Tube life depends on the character of the water supply, on the chemical, physical and metallographic properties of the tubes (crystalline structure) and it also depends on the design of the condenser.

Velocity has a direct effect on corrosion. Low velocity allows the deposit of foreign matter in the tubes which forms obstructions around which the products of corrosion accumulate in concentrated form, with the resultant pitting. High water velocity keeps the tubes clean and eliminates this form of corrosion.

High temperature accelerates corrosion of all types and so seriously that a temperature of 95 deg. F. is recommended as the maximum. There are three ways of reducing temperatures in order to alleviate corrosion: by increasing the water quantity, thus decreasing the overall rise; second, by eliminating hot spots and local over-heating of tubes; third, by increasing water velocity or decreasing tube size, thus decreasing the skin temperature at the tube wall.

In Fig. 3 in which steam distribution is obtained by lanes L L, the tubes A A are in the path of the steam and heat the water rapidly to a high temperature,

* From a paper read before the Baltimore Section A. S. M. E.

whereas the tubes B B are short-circuited and insulated by air which cannot be swept away because there is no current of steam. The excessively heated water from the tubes A A mixes with the cold water from the tubes B B, and this condition is not detected except by delicate local temperature readings. The short-circuited tubes are not only wasted surface, but are the cause of the excessive temperature in the exposed tubes, which consequently corrode rapidly.

In a condenser with proper distribution to avoid hot spots and waste surface, and with suitable velocity and tube diameter further to reduce skin temperature and prevent foreign deposits, a markedly longer life of tubes will be obtained. As will be seen, too, these features of design result in small initial surface requirements, so that there is a two-fold reduction in the fixed charges to take care of replacements. The greatest reduction in initial surface requirements is obtained by eliminating waste surface; the use of high water velocities results in a further and secondary reduction in tubes required.

Operating Charges

The principal operating charges on a condensing plant may be grouped as follows:

Reduction of condensate temperature below steam temperature and consequent loss of coal.

The power for operating the auxiliaries.

The reduction of vacuum and increased coal consumption due to scaling and sliming of the tubes.

The cost and time lost to clean the tubes and the cost and time lost due to tube failure and consequent pollution of the boiler feed.

Reduction or depression in condensate temperature below steam temperature depends on condenser design and temperature of circulating water, being less with warm water and greater with cold water. The water of condensation must fall over successive rows of tubes to reach the bottom and if the steam is not drawn down to the bottom of the condenser the water will be gradually cooled. The colder the water and higher the vacuum the greater the proportion of idle surface and the colder the condensate. In older condensers there is a depression of condensate temperature of 5 to 10 deg. in summer and 10 to 20 deg. in winter.

The principal item of power consumption lies in the circulating pump, and this unit is often arranged for variable speed drive or else is divided into two smaller units, so that with cold water or light load the operating charge may be reduced by slowing down or by shutting down one pump. As shown in Fig. 2, an excessive vacuum is obtainable in the winter and the waste of fixed charges can be partially offset by saving on the circulating pump power.

Low pump power with low water velocities may be offset by increased operating charges due to low vacuum resulting from fouling. The shaded portion in Fig. 2 indicates the range of vacuum in the summer time under actual conditions of fouling of condenser tubes. As much as an inch of vacuum is lost in a week in some cases. In one extreme instance there is a loss of an inch in two days. It is unfortunate that the loss by fouling is most severe in the summer when it is most difficult to obtain high vacuum. As a reduction of only ¼ in. in vacuum represents a loss of 1½ to 2 per cent of turbine economy, which may be equivalent to all the auxiliary power, it is readily seen how easily all calculations of exact balance between fixed charges against the condenser and operating charges against the auxiliaries may be disrupted.

The foreign matter that accumulates in condenser tubes may be divided into three classes:

1. Mechanical deposits, silt and mud.
2. Scales deposited out of solution.
3. Slimes or organic growths.

The first of these is of minor influence in reducing vacuum unless water velocities are low indeed. The ability of a stream of water to carry solid substances in suspension increases rapidly with increase of the velocity. Foreign matter such as silt, however, may be deposited in slime coatings which form a more adherent surface than a clean condenser tube.

The second form of deposits is common with salt water and hard waters carrying scale forming salts, familiar in impure boiler feed water. In many cases with cooling towers or spray ponds the source of make-up is a relatively hard water and causes deposits of sludge and scales in the condenser tubes. The commonest in-

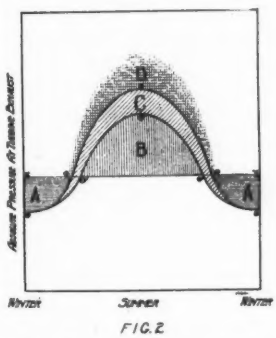


FIG. 2

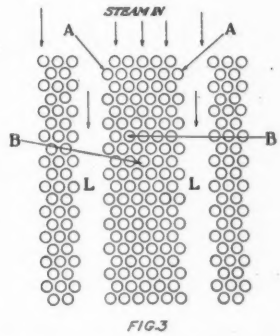


FIG. 3

FIG. 2. CYCLE OF ABSOLUTE BACK PRESSURE OF YEAR
FIG. 3. STEAM DISTRIBUTION LANES

gredients of such water are calcium and magnesium carbonate which are soluble in the presence of carbon dioxide. Heating the water drives off the CO_2 and precipitates the carbonates.

Where extremely hard waters are encountered, it is desirable not only to keep down the temperatures by observing the principles of high skin velocity and activity, but also by using larger quantities of water and smaller overall temperature rise. In this way, it is possible as between two condensing plants to reduce the maximum temperature rise of the skin of water in the hottest tubes, 10 or 20 deg. or even more.

Slimes or organic growths are the third form of deposits. Fouling of this character is most severe in the summer time, and is also most severe in hot portions of a condenser with improper steam distribution. Thus, in Fig. 3, the tubes A A will be found coated with a thick, heavy slime in a short time, whereas tubes B B in the short-circuited regions will be but slightly fouled. It is probable that these slimes are organic growths occurring under the ideal conditions of warmth and stagnation existing at the inner skin of the tube.

The same arrangement of tubes to prevent local overheating, and the use of high water velocities to reduce inner skin temperatures and increase the activity and

counteract stagnation along the inner wall of the tube may be expected to reduce and eliminate the formation of organic slimes. Corrosion, scaling and sliming can all be reduced by correct proportion of a condenser for high activity of water flow and turbulence at the tube wall and uniform steam distribution, factors, which in addition permit of a large reduction in the amount of tube surface.

Fouling adds to the operating charges in another way, as there may be a large labor cost for cleaning. The time loss with a unit out of service is also a considerable item of cost. The charges due to failure of tubes by splitting and corrosion are of a similar nature. The pollution of the condensate and consequent scaling of the boilers from either impure condensate or from raw feed water adds to the operating charge of the boiler room. The loss of time on the complete power generating unit required to shut down, locate, and plug the leaking tube adds to the turbine room operating charges.

Refinements of Practice in Modern Power Plants

TURNING STEAM INTO COLD PIPE LINES; HANDLING HOT WATER; PRECAUTIONS FOR INSTRUMENT PIPING; FLUE DUSTS AND THEIR CHEMICAL ACTIONS; MOISTURE IN SUPERHEATED STEAM LINES. BY I. L. KENTISH-RANKIN

THAT care is required in turning steam in cold pipe lines is generally appreciated. Yet accidents still continue to occur to pipes during and soon after steam has been turned into them.

Experience shows that comparatively few pipe failures occur on account of steam pressure alone, but that it is steam pressure superimposed upon some other condition that results in failure. Vibration is one cause of failure, because crystallization, fatigue and eventual fracture at normal pressures takes place. Water hammer is another condition that can be guarded against when installing the piping system. Water hammer is the action that takes place when water that has collected in a pipe is shot forward by the on-rushing steam. Condensation creates a partial vacuum in the pipe which enables the steam at high velocity to send the slug of water through the pipe with terrific force. A sudden bend in the pipe, a fitting or similar obstruction (especially when of cast iron) may be forced out of the way—and an explosion follows. The remedy, of course, is to employ only bends of large radii and drain the pipe so that condensate is removed as it forms or before steam is turned on.

Pipe failures occurring during or shortly after steam is turned in a cold line are almost invariably due to expansion. As the atomic forces of contraction and expansion are irresistible, they are generally taken care of by bends, expansion joints, etc; however, when steam is turned in a cold line a set of conditions may arise that cannot be taken care of in the above-mentioned way. The condition referred to is due to unequal expansion in a pipe itself; for example, considerable expansion at the top and small expansion at the bottom of the pipe, so that bending takes place. This condition strains joints and welds; it tends to rupture fittings by producing a compression on the upper and a tensile strain on the lower sections of flanges, etc.

There is good reason to suppose that entrained air in the pipe is indirectly the cause of many such pipe failures. This is even more true of large than small pipes probably. The density of air is about twice that of steam. When steam slowly enters a horizontal pipe, the air lies on the bottom while the steam passes along the upper zone of the pipe. Naturally, therefore, the upper section of the pipe is heated more rapidly and to higher temperature than the lower section on account of the layer of air that separates steam from pipe acting as a heat insulator. The upper section of the pipe expands rapidly and radically while the bottom section expands less and more slowly because of the lower temperature.

Strains and bending ensue and fittings may be broken by the intense leverage exerted over a considerable length of pipe.

That the above explanation is correct in explaining many pipe failures seems to be demonstrated in practice. On this hypothesis, one would expect large pipes to be somewhat more susceptible to this trouble than small pipes because of the greater likelihood of stratification of air; the greater thickness of the layer of air and steeper temperature gradient therefore; and because of the greater rigidity of large pipes.

The remedy is, of course, to prevent air from remaining in the pipe after steam is turned on. Fortunately the remedy is simple. It is to turn on the steam in sufficient quantity to drive out all air as the steam passes along the pipe. When this occurs and the pipe is filled with steam, heating is uniform. To do this, all air vents and drains should be opened and the steam valve opened quickly one-quarter to one-half full opening. This sends a good sized volume of steam into the pipe which drives all air before it.

In other words, turn steam on a cold line quickly instead of slowly if traverse strains are to be avoided. Design the piping system so that water hammer will not occur, nor do harm if it should; take care of longitudinal expansion in the orthodox way, namely by long-radii bends, expansion joints, etc., and prevent traverse strains by removing entrained air.

HOT WATER HINTS

ONE MIGHT suppose that hot water has been pumped for so long and on such a vast scale that little remains to be said about how to do it. Notwithstanding, however, many of the smaller plants experience difficulty from time to time and consider them inherent to hot water. The truth is that plant layout is to blame, layouts that could be easily remedied. It may prove illuminating to recapitulate a few of the salient factors contributing to successful hot water pumping.

The main difference between hot water and cold water is that when the pressure of hot water is reduced —as by the suction of the pump where insufficient gravity head exists to force water after the piston—the water tends to vaporize and give off steam. When this occurs, a partial vacuum is formed, the pump becomes air and steam bound, and it balks and knocks. The one single remedy for this condition is to maintain ample

head so that there is positive gravity feed to the pump at all times.

This generally means a head of not less and preferably more than 3 ft. between the pump valves and the heater water level must be obtained, either by lowering the pump, raising the heater or both. A fact often overlooked is that the centrifugal pump requires a much higher head than does the reciprocating pump because of the higher velocity at which the water travels with the former. Where a minimum of 3 ft. may suffice for the reciprocating pump, 8 ft. or more are always advisable for the centrifugal pump.

A mistake commonly made is to use a pump too small for the job. The pump is speeded up in the effort to attain capacity and consequently it is impossible or difficult to keep a solid body of hot water behind the piston. A partial vacuum occurs and the pump knocks and balks. High pump speed and insufficient gravity head cause endless trouble to which may be added excessive valve tension and restricted valve seats.

When the gravity head is sufficient and the pump is still troublesome, one immediately suspects excessive frictional loss through the pipe connecting pump and heater. Liberal pipe sizes should always be used for hot water, and sizes larger than for the corresponding quantity of cold water. Bends should be minimized, the water should follow as direct a path as possible, the number of fittings should be cut to the minimum and the air and steam pockets avoided. Even the form of valve used is worthy of consideration; for example, the gate valve offers less obstruction to the flow of water than does the globe valve; you will often find the former used where pumping hot water has received deliberate consideration.

Increasing the size of pipe counteracts the effect of long lines and high frictional resistance. Doing so is often a way of helping an overloaded pump and allowing increased piston speed without the pump becoming air and steam-bound. Another practice that often overcomes a troublesome condition is to install a standpipe in the supply line close to the pump, so overcoming the objections of a long line and small gravity head by keeping the pump supplied with water. The stand-pipe should be vented to the atmosphere to prevent air-binding and should extend well above the highest possible water level.

Troubles in pumping hot water indicate something radically wrong with the pump or the piping. The practice, which is far too common, of injecting cold water into the hot-water line to overcome these troubles, is pernicious because it is wasteful, because it tends to undo what the heater has done and because it merely lessens the effect instead of reaching to the cause. There is little excuse for hot-water pumping troubles.

Instrument Piping

Any boiler-room instrument that is properly used will pay for itself within 2 yr.; many pay for themselves in 6 mo. For this reason, boiler-room instruments are now recognized as being necessary for boiler room economy. No boiler-room is complete without its proper complement of instruments, draft gages, steam-flow, CO_2 and stack and hot water thermometers, perhaps.

Yet, in many cases, no provision is made for these instruments during the time the plant and piping is being designed; so that when the time comes to install them, an afterthought, they must be put where space exists, piping is complicated by many bends and of much greater lengths than had the matter been given consideration when the piping system was first designed. Is it any wonder, then, that instrument piping often gives trouble? Is it any wonder that instruments come into disuse because of defective piping?

In one plant recently containing eight steam-flow meters, not one was working. Extensive repairs have been going on for about a year. The instrument piping leaked, it had been frozen during last winter and the instruments were so covered with dirt that the dials could hardly be seen. Here was an investment of several thousand dollars doing nothing; the psychological effect was extremely injurious to the morale of the boiler-room crew and to the interests of boiler-room economy. This plant was not unique. There are many more like it. People think that if they buy instruments they need do no more. They overlook the fact that they must be properly installed; their significance must be understood; they must be maintained in proper working order and someone must be responsible for their use.

Because instrument piping is small and not of paramount importance in keeping a plant running is no reason why it should be erected in a slipshod manner so that it is improperly supported and vibration and fracture and leaks follow in natural sequence. For steam-flow meters, brass pipe is superior to iron. All pipes should be securely supported and protected against damage. Air pockets should be avoided and provision made for removing condensation. Joints should be made securely and for permanency, as a small leak will make an instrument inaccurate. The use of a mixture of litharge and glycerin will be found preferable to white lead for making tight joints that will remain tight a long time.

It is generally cheaper to do a good job at the start. This is absolutely true of instrument piping. Do a good job and keep the piping in good shape by occasional inspection. Were this done more, many instruments now doing nothing would be paying for themselves once or twice a year, making money for their owners and saving work for the men who use them.

External Deposits

The collection, analysis and study of the external deposits on boiler and economizer tubes, in the breeching and elsewhere, is of absorbing interest and of great practical importance. The summer months and the seasonal overhauling that generally goes on are extremely opportune for collecting samples of external deposits. Such a study may bring to light unsuspected conditions and point the way to their alleviation; it introduces a new interest and gives the dirt and dust a new aspect.

In a fuel bed there is an excess of carbon and only when the combustion chamber is reached does an excess of oxygen occur. This means, of course, that a powerful reducing agent is present to work upon any combustible matter in the ash constituents. These generally contain certain amounts of alkali metals which pass into the combustion space with the other gases of combustion after being reduced from their salts. Sodium is almost

always found in the ash of coal and potassium occurs frequently. Sulphur, generally in the form of pyrites, and sometimes as sulphate of lime, also exists so that sulphur is distilled off with the other volatile gases. Lead, bismuth, zinc and even copper, all being reductible by carbon, are occasionally found in the flue gas dust.

The gases in the combustion chamber always contain sodium in the state of vapor which later is converted to sodium oxide and still later into sulphate of soda. It is rather surprising the large amount of sulphur involved; in fact, effort has been made by some of the largest central stations to recover sulphuric acid from the furnace gases upon a commercial scale, and potash from the ash-pit refuse. A sulphur content of 1 per cent or 22 lb. per ton and higher occurs in many coals; the alkali metals will range from 6 to 20 lb. of sodium oxide per ton so that the production of these in the course of a year is quite appreciable.

As there is an excess of oxygen in the gases of combustion as they pass into the combustion chamber, the volatile metals and the sulphur burn and by combining with oxygen form oxides of sodium, potassium, etc., and sulphuric acid. Sulphate of sodium forms when the oxide of sodium unites with the sulphuric acid; as sulphate of sodium is a comparatively infusible salt it condenses upon the comparatively cool surfaces of the boiler or other surfaces in its path. The white deposit often seen on boiler tubes is sodium sulphate; it interferes with heat transmission to some extent. Of itself it is not otherwise detrimental so long as the temperature does not reach above 1700 deg. F., at which temperature it melts, giving up oxygen to the iron and becoming very corrosive.

Internal scale on boiler tubes often causes the sulphate of sodium on the outside to melt, to form a scab which repeatedly breaks and reforms with the expansion and contraction of the tube that takes place with radical temperature changes. Eventually under the gradual weakening of the tube, bulges, bags and final failure may occur. In all probability, internal scale is blamed; but it is the combination of internal and external scale that is really responsible. It is not the oxygen in the flue gases but the oxygen supplied by the adhering coating of sulphate of sodium that eats away the metal.

Have you ever noticed that boiler tubes thrown onto the scrap pile often turn yellowish? This is because the sulphuric anhydride is hygroscopic and takes up moisture from the atmosphere. It then attacks iron. A similar condition arises in a boiler, but to a lesser extent, when a boiler is taken out of service or when there is condensation and leakage going on. On economizer tubes bisulphate is more often found on account of their lower temperature compared with boiler tubes; the bisulphate is deposited without an extraneous moisture other than that of the flue gases. Bisulphate is extremely hydroscopic so that while harmless when dry it is extremely corrosive when damp, forming ferric and ferrous sulphates and in so doing changes in color from white to yellowish green.

An analysis of the deposits on your tubes will show what is going on. As leaks, sweating and low gas temperatures are the predominating sources of moisture, it will be found that the tubes receiving the coolest feed water and those tubes located nearest the cleaning doors will be the ones most troubled with deposit of bisulphate and therefore where corrosion has made the most headway.

The brickwork is not immune from the deleterious effects of the sodium in the furnace gases. Sodium, existing subsequently as sulphate of soda, is deposited upon the brickwork with very objectionable consequences. Fireclay is infusible so long as it is free from alkalies; but it is particularly amenable to the action of alkalies such as sodium oxide. Slag and fusion occur and glazing and fluxing take place, being the disintegration and destruction of the brick. At high temperature, sodium oxide renders ash both plastic and binding. Small particles of ash carried upward by the draft mix with the sodium oxide to form a coating of silicate of soda. It is the agglutination of these particles around boiler tubes that has to be removed by force in order to overcome the obstruction of the gas passages and therefore the draft.

Steam Separators

One sometimes hears the remark that steam separators are not really required in plants employing superheated steam of 125 deg. F. and above. It is true that there is less liability of there being entrained water in steam where a superheater is used than where one is lacking; but even so the separator is a useful and often justifiable piece of apparatus.

With bad water so that priming occurs and with heavy rates of evaporation moisture is often carried over past the superheater. Precipitate proves this even though there may be no other sign of entrained moisture. It is cheaper to install a steam separator than to have slugs of water carried over to the engine, to wash out lubricant, introduce a danger, erode and corrode turbine blading and introduce a sudden temperature change and lower efficiency generally.

The steam separator possesses other advantages than that of separating moisture from steam, however. For one thing, it provides a very convenient place for draining the piping close to the turbine, where good drainage is probably of most importance on the score of turbine performance. Its use simplifies piping lay-out and makes for higher economy. It should be remembered, however, that a steam separator is not supposed to hold back large quantities of water nor store large accumulations. The steam separator to be successful must be of ample size and must be able to drain off all water taken up. With reciprocating engines where the flow of steam is less steady than with turbines, and is in fact periodic, a separator serves as a storage reservoir, thus equalizing steam flow.

In choosing a steam separator probably the two most important considerations are that it have ample capacity and that the drainage be sufficient to assure the ready disposal of entrained water.

Various large manufacturing concerns have indicated their willingness to co-operate in the investigation at the Pittsburgh experiment station of the Bureau of Mines of the corrosion of metals in mine water. Corrosion tests will be started shortly in three typical coal mines of Pennsylvania. The test pieces will be immersed in the water for a period of time, then taken out, measured, and the degree and character of acidity noted.

Power Plant Records and Accounting

COMPREHENSIVE SYSTEM OF DISTRIBUTING COST OF POWER PLANT SERVICE TO THE SEVERAL DEPARTMENTS. BY EINAR WINHOLT

UNDOUBTEDLY most power plants have some kind of system of plant records, the larger plants especially. Public utilities plants in nearly all the states are required by law to keep records of plant operation and the proper accounting system in connection therewith. Therefore this article is especially directed to the industrial power plant.

Some years ago when coal was inexpensive in comparison to the prices that have been paid during the last years, very little effort was made to save on the fuel bill in the industrial power plant. When the management was approached on that subject, the answer was generally, "Our total cost of operating our power plant is only two or three per cent of our total gross expenditure. Why should we bother about such small items? We keep our eyes on the big expenses." "A dollar saved is a dollar earned," however, and a dollar saved in your power plant is as good as the dollar saved in the remainder of the factory. It may be that the power house bill is only two or three per cent of the total expenditure but it represents many times that part of your net profits.

Just suppose that the net profits are 10 per cent and power house operation is 2 per cent of gross expenditures, then your power is equal to 1/5, or 20 per cent of the net earnings of the plant. There are few industrial plants where a saving of 25 per cent cannot be made if proper efforts are put in that direction. In that case, the total power house expenditure becomes only 1½ per cent of the total expenditure and the net profits consequently 10½ per cent, an increase of 5 per cent above the previous figure. The one-half of one per cent to power now becomes 5 per cent increase in net profits, an item which certainly is noticeable to the owner of the factory or the stockholders.

Industrial conditions have changed since the war and hereafter the factory that can produce at lower cost than its competitor will stay in business, while the others must reduce cost or quit. Therefore we can readily see that as power, heat and light enter into all products, the engineer and the operation of the power plant have much to do with the price of the finished product and the ultimate net profits of the industrial plant.

KW-Aug-18-1920 Form E-1.

Power Plant Record

Plant 12:01 A.M. To 12 MN on Day of 192

KW Hr. Purchased D.C.	Water Fed Boilers Lb.
" " " A.C.	Coal Burned
" " Produced	Refuse Burned
Cap. of Gen. x Hr. Oper:	
Load Factor	Water Evap. Per Lb. Fuel
Power Factor	Boiler H.P. in Use
	Max. Demand on Boilers at
Cu. Feet of Free Air Compr. M	Average Demand
Cap. of Compr. x Hr. Oper: M	
Load Factor	
	Heating System
Low Pressure Air	
Water Pumped	Avrg. Pressure Heat
Refrigeration	Avrg. Outside Temperature

Fuel & Supplies	Plant Coal-Tons	Storage Coal-Tons	Oil & Lubricants Gal. Cyl-#1	Cyl-#2		Eng.#1	Eng.#2	Comp.	Waste-Lb.	
On Hand 12:01 This A.M.										
Received Today										
Total										
Consumed Today										
On Hand 12:00 This P.M.										

Remarks:

Work Done in Plant Today:

Boilers Cleaned Last Time	#1	2	3	4	5	6	7	8
Date:								

Load Factor = Output / Cap. Per Hr. x Hr. Oper. _____ Chief Engr.

Make This Record in Duplicate E-418-X

FIG. 2. DAILY RECORD MADE UP FROM FIG. 1

E.W.-AUG.18,1920 PLANT LOG FORM-A-1

PLANT _____ DATE _____ 192__

TIME	PURCHASED ELEC. AMPERE HR.	PURCHASED ELEC. KW-AC	PURCHASED ELEC. KW-D.C.	PRODUCED ELEC. AMPERE HR.	PRODUCED ELEC. KW.	AIR COMP. REV. #1	#2	#3	FEED TEMP.	FEED PUMP STROKES #1	#2	SHOP PUMP	IN OPERATION UNITS	BOILERS	OUTSIDE TEMP.	HEAT PRESS
12 MN																
1 A.M.																
2																
3																
4																
1																
12 MN																
TOTAL																
CONST.																
TOTAL		KW. HR.	KW. HR.		KW. HR.	M. CU. FT.	M. CU. FT.	M. CU. FT.	AVRG.	LB.	LB.	M. GAL.			AVRG.	AVRG.

MAKE IN DUPLICATE E-418-Y

FIG. 1. FORM FOR DAILY POWER PLANT LOG

The industrial plant generally maintains a cost system showing the cost of labor and material entering into each piece of the finished product, whether it be small or large, and giving such cost in figures with several decimals. Such is not the case where the power plant is concerned; many places the entire cost of operating the plant during the fiscal year is known; some can show the total figure spent for fuel and labor; but very few know what part is usefully employed or what part constitutes a preventable waste, nor do they know what part of the output from the power plant is produced at a reasonable or what part is produced at an excessive cost.

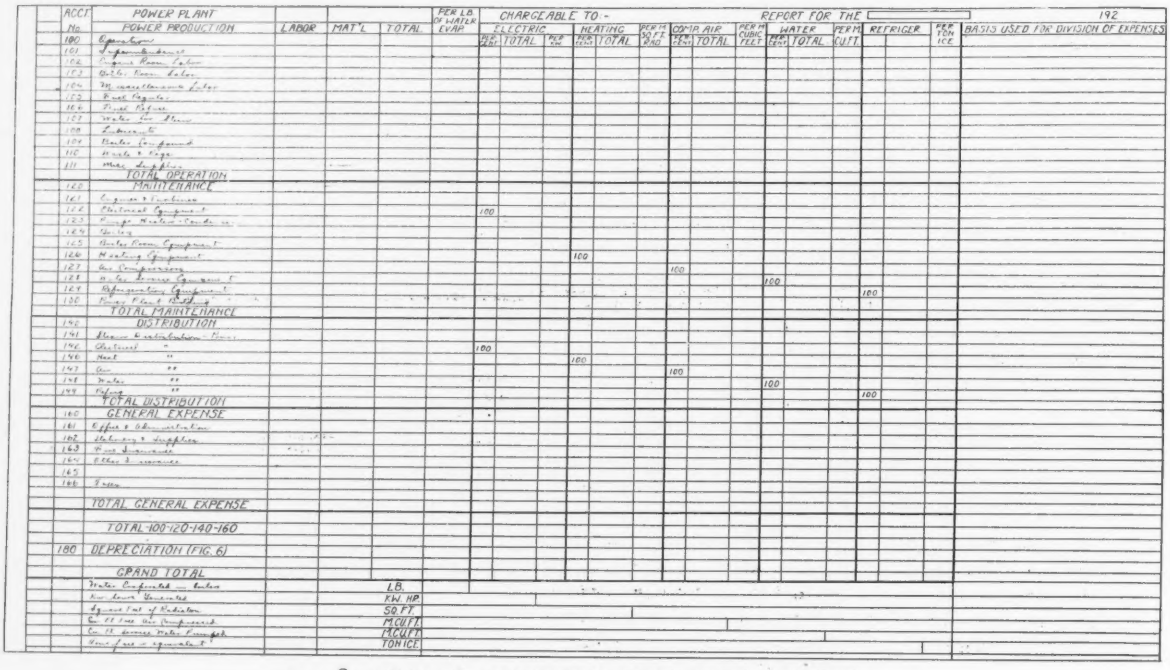


FIG. 3. FORM FOR CLASSIFYING POWER PLANT EXPENSES

(1) Amount of fuel used.
(2) Water evaporated in boilers.
(3) Output of plant.

It requires only few instruments in the plant to give the three items listed above and the plant that does not know these three is just like a store operating without a cash register.

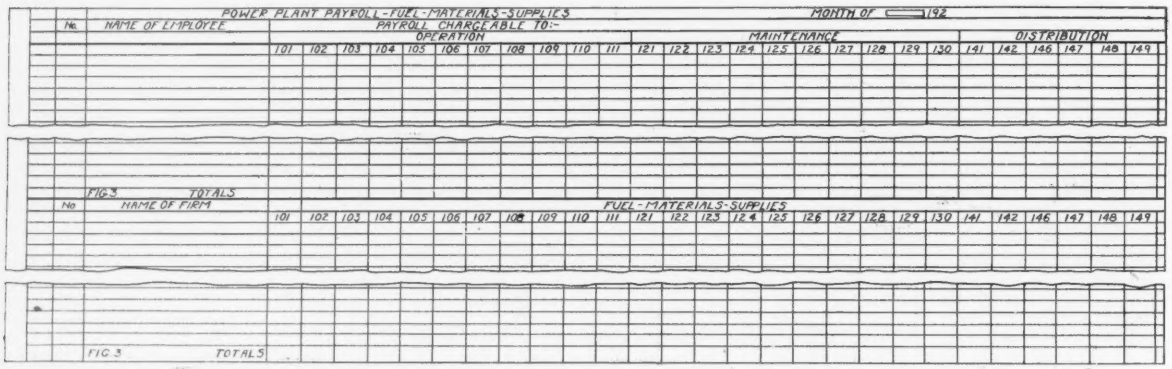


FIG. 4. FORM FOR RECORDING COST OF LABOR AND MATERIALS

Consequently they have nothing to guide them when it comes to eliminating waste in the power house. To bring the power house to the same plane as the factory proper, it is necessary to have a system of plant records and the proper cost accounting therewith.

A classification must be adopted and invoices for materials and supplies, as obtained from the purchasing department, and labor, as obtained from the time cards by the time keeping department, must be listed in the proper place.

A daily plant log must be kept showing the daily output of power, heat, light, water, etc. There are three essentials which must be known about the power house in order to obtain correct cost:

A simple form suitable for daily power plant log is shown in Fig. 1. It can contain hourly readings or at such intervals as is desired according to the nature of the industry.

Form Fig. 2 is a daily record made up from the readings on the log sheet; a similar form can be used for weekly, monthly and yearly record.

A classification suitable for power plant expenses

is shown in Fig. 3. This provides both for production and distribution. In case the distribution expense is taken care of under shops or buildings, this division can be disregarded. Figure 3 is a total sheet and should be properly filled out at the end of each month.

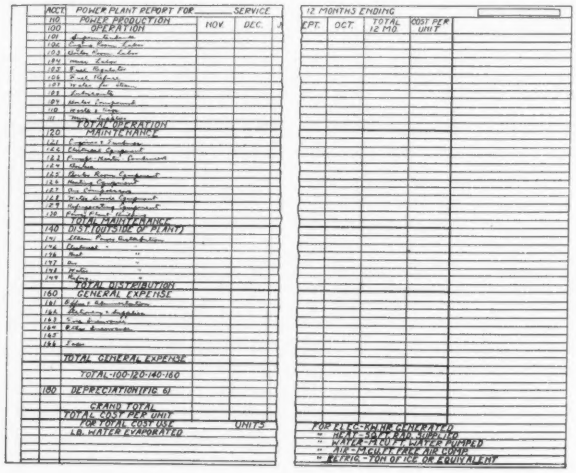


FIG. 5. ANNUAL REPORT OF POWER PLANT EXPENSES

The figures for Fig. 3 are obtained from Fig. 4, labor and material. The plant output is secured from the monthly sheet similar to Fig. 2 which in turn is made up from daily sheets Figs. 1 and 2.

From Fig. 3 the total column for each kind of service is transferred to a yearly sheet, Fig. 5. (There will be one such sheet for each kind of service rendered at the factory in question.) To bring all the totals within easy reach, the final columns from the several yearly sheets, Fig. 5, are transferred to one yearly sheet, Fig. 3, which becomes the master sheet.

The percentage used in distributing the expenses between the different services must be worked out for each plant separately and according to local conditions. The local plants should work this out with the assistance of the engineering department.

The annual depreciation and capital invested is listed on sheet Fig. 6 and is distributed between the different lines of service from the power plant. From Fig. 6 it is transferred to the monthly or yearly sheet.

The payroll and material sheet, Fig. 4, is kept weekly or monthly, according to the size of the payroll and purchases. The totals from this sheet are transferred to the monthly sheet, Fig. 3.

Attention is called to the fuel account Nos. 105 and 106. No. 105 should contain the regular power plant fuel purchased. No. 106 should cover refuse burned from the manufacturing shops. This fuel should be charged at its equivalent coal value to No. 106 and the manufacturing expense credited with the same amount.

The above outlined system of plant records and accounting when properly carried out, should show the following:

TOTAL COST OF OPERATING POWER PLANT

COST PER ONE POUND OF WATER EVAPORATED

Amount chargeable to	Cost per
Heat	Sq. ft. of Radiation
Electric	kw.-hr. produced
Air	1000 cu. ft. of air compressed
Water	1000 cu. ft. pumped
Refrigeration.	ton of ice (or equivalent).

Further, each item entering into the foregoing costs will be shown separately, thus enabling the management

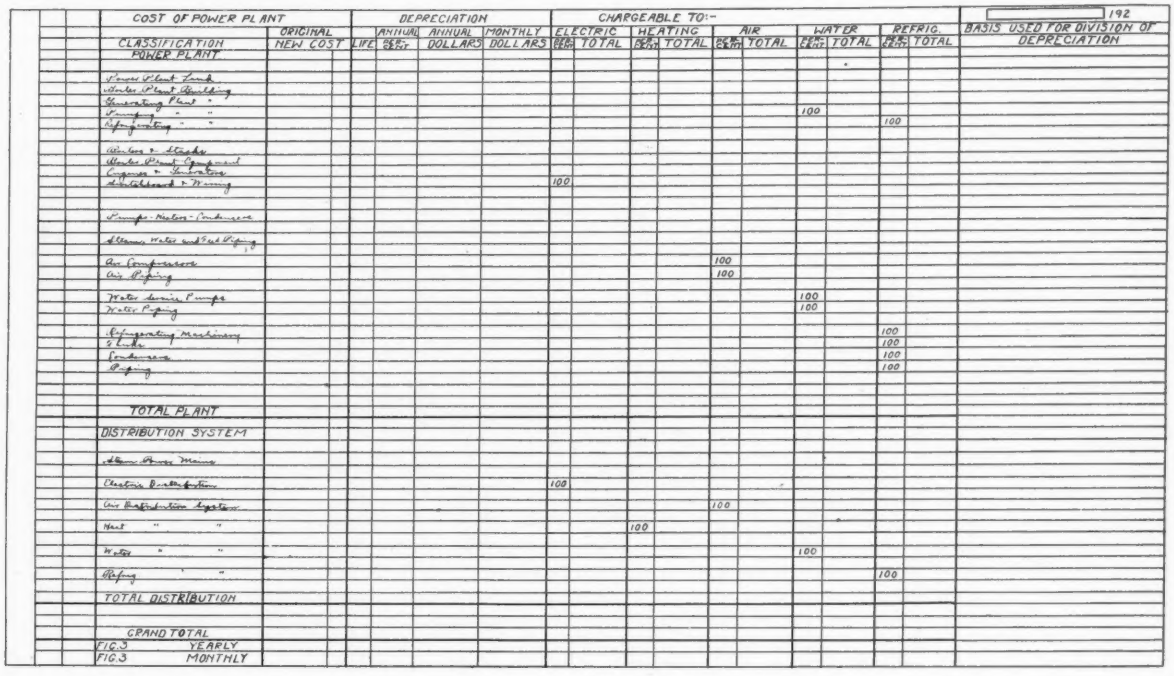


FIG. 6. FORM FOR RECORDING DEPRECIATION AND CAPITAL INVESTED

or the chief engineer to investigate any weak point as brought out by the records.

With such records, each plant must stand on its merits, the well operated plant to get the credit due to it, while the inefficiently operated plant should re-

ceive prompt attention in order to remedy the faulty conditions.

The system as outlined above covers a variety of services rendered from one plant; if more lines of service are given, proper additions must be made or vice versa.

To make such a system successful, it is important that proper instructions are issued and that the personnel employed in the power house fully appreciates the value of a correctly kept record and account system.

To many operating engineers, this method may look complicated at first glance; but by getting acquainted with the classifications, it will soon be found that it is all very simple and as far as the plant records are concerned will require only a few minutes every day.

If the chief engineer has sufficient help, it may all be handled from his office, otherwise it is a matter that the timekeeping or shop accounting department can take care of very easily. It cannot be disputed that the factory manager and the engineer who has correct information about the itemized cost of operating the power house is in a position to effect maximum efficiency for all kinds of service.

The price of coal is not expected to be reduced much below present prices and will probably never reach the low levels prior to the war, therefore the thing to do is to utilize the fuel to better advantage than was formerly done by using in the power plant up-to-date equipment, up-to-date men, up-to-date methods.

Novel Boiler Installation for Burning Wood Refuse

GASES FROM SEPARATE DUTCH OVEN FURNACE ARE CONDUCTED THROUGH TUNNEL TO STOKER FURNACE AND BOILER. BY C. W. SMITH

FOR MANY YEARS most factories, whose manufacturing processes yielded large quantities of wood refuse, considered the burning of their refuse more from the standpoint of an easy disposal rather than as a source of fuel supply. This was and is still true to a certain extent in many pulp and paper mills throughout the country, where large amounts of refuse in form of sawdust, chips, shavings and wet bark are available, but which, on account of its high percentage of moisture, varying from 55 per cent in winter to as high as 65 per cent in summer, is very difficult to burn on a common grate and dutch oven.

The company with which the writer is connected made a thorough study of the various means of treating the wood refuse for the purpose of eliminating the moisture contents and after having made in their own mill quite a number of experiments to determine the most feasible way of burning their wet refuse economically, decided to install a burner designed by the writer for the special purpose of burning wet bark and other pulp and paper mill refuse.

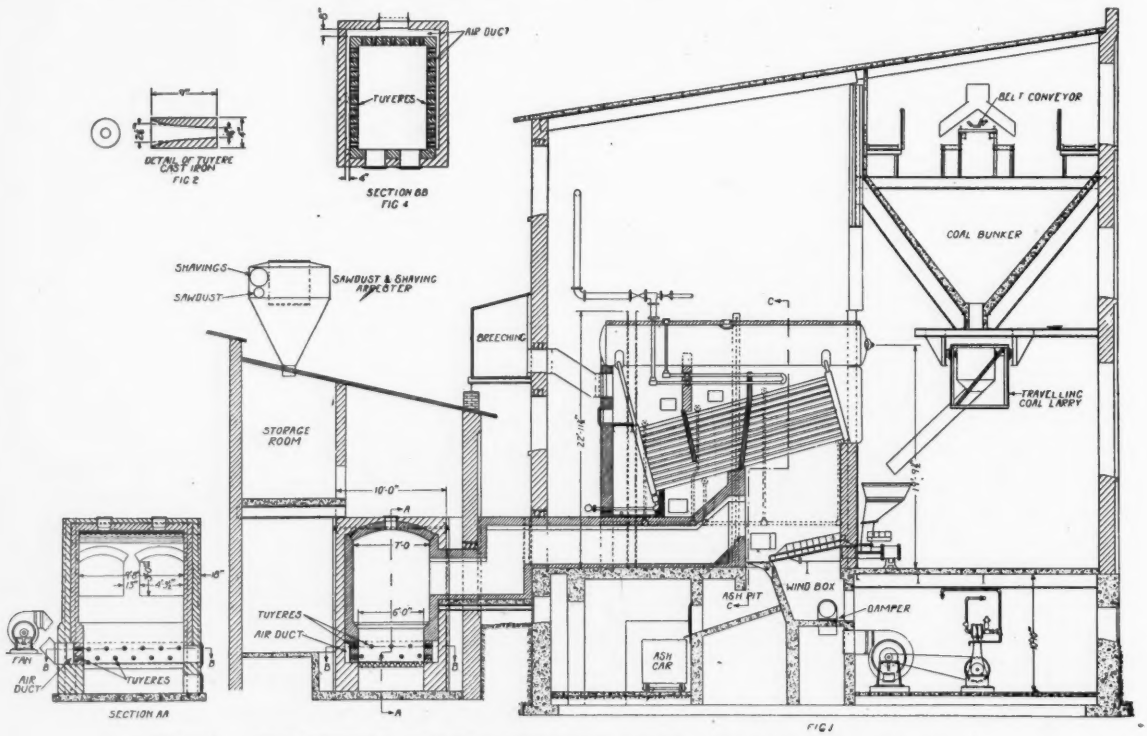


FIG. 1. TRANSVERSE SECTION THROUGH BOILER AND WOOD REFUSE BURNER.
FIG. 2. DETAIL OF CAST IRON TUYERE. FIG. 3. SECTION ON A-A. FIG. 4. SECTION B-B

In Fig. 1 is shown a longitudinal section through the complete installation, consisting of boiler and separate dutch oven. The boiler proper is a 400-hp. B. & W. boiler built for 200 lb. pressure, 12 tubes high, 16 ft. wide, equipped with Foster superheater and a standard

Jones "AC" underfeed stoker, four retorts wide, which enables the boiler when burning coal alone, to develop as high as 1200 hp. or 300 per cent rating. The refuse burner is of standard design with walls 18 in. thick, a grate surface made of standard 3 ft. section or 9 ft. overall and 6 ft. wide.

Due to the layout of the building adjacent to the boiler house, it was impossible to enlarge the boiler room sufficiently to locate the dutch oven directly behind the boiler and it was necessary, as can be seen from the illustration, to place the refuse burner outside the boiler room in a separate building. The latter, besides containing the storage for the sawdust, shavings and wet bark, also contains the fan equipment for the dutch oven which, however, is only used when burning a very large amount of refuse or wet bark only. The sawdust is delivered to the cyclone by means of a blower, and the bark is brought from the barking building on a series of belt conveyors.

Air Supplied Above Grate

To do away with the objection toward the common practice of burning refuse on grates where the air enters the furnace through the grates, which causes the fuel to burn faster wherever the fuel bed is thinnest, with the consequent results of having continuously excess air passing through the holes in the fire, several rows of tuyeres are placed about 6 in. and 12 in. respectively, above the grates, symmetrically around the furnace. All tuyeres are connected to an annular air duct in the brick wall which in turn is connected to a small motor-driven blower of a size large enough to furnish sufficient air at about 1 in. static pressure. The air supply can be controlled by a damper placed between the fan and the air duct.

The tuyeres, 30 in number, are of a cylindrical shape, made of cast iron, and are shown in detail in Fig. 2.

To comply with the most essential feature in the design of a furnace for wet fuel, that is, the provision of a large combustion space and a long travel of the gases over heated brickwork before striking the cold boiler tubes, the space above the grates is made 12 ft. high. This provides ample combustion space and also a large surface of heated brickwork. The connection from the dutch oven to the boiler is built tunnel-shape of ample size, with rectangular turns to insure the thorough mixture of the gases so essential for the complete combustion of the gases. Figures 3, 4 and 5 show cross sections through the boiler, giving all details.

The ash pit and fire doors are kept closed at all times, except when cleaning the fire and removing the ashes. All air is admitted through the tuyeres above the grates. The fuel, consisting alternately of partially dry sawdust and wet bark, is fed through two openings at the top. Particular care is taken to have the refuse piled up highest at the outside edges of the grates; generally from 2 to 3 ft. high.

The hot gases pass from the dutch oven through the two long brick tunnels described above, entering the combustion chamber of the boiler proper just above the bridge wall of the stoker. There they are thoroughly mixed with the gases from the stoker fire and pass through the several passes of the boiler into the breeching.

Normally only a very light coal fire is carried on the stoker, just enough to cover the stoker grates and also to make it possible to start the stoker quickly in case the refuse supply should give out or a heavy steam demand should occur. Where the air is admitted through the tuyeres over the grate, it impinges on the fuel bed to an extent of 3 ft., that is when running with natural draft. This installation has been in operation every day since April and has given entire satisfaction. No trouble has been experienced with the accumulation of unburned particles in the combustion tunnels; often the flames can be seen traveling the full length of the tunnels and even entering the combustion chamber of the boiler proper. We find that we can fire either the dutch oven or the stoker alone or both at the same time with very good results. The boiler is now equipped with recording steam flow meter, draft and wind box pressure gages and CO_2 recorder and arrangements are now being made to weigh the refuse as fired. It will then be possible to

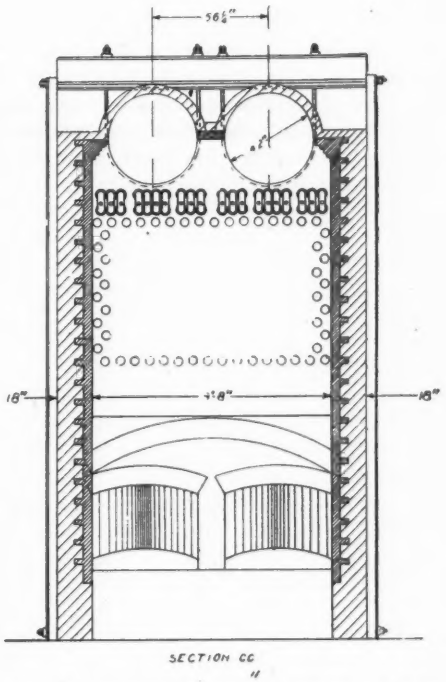


FIG. 5. SECTION THROUGH BOILER ON C-C

determine exactly what evaporation we are getting from the refuse.

During a series of tests, we found that when burning wet refuse alone we could develop 435 hp. and over 1300 hp. when burning coal and refuse together, this being as high as the flow meter would record.

The usual draft in the boiler combustion chamber is about 0.3 in. and about 0.6 in. at the breeching damper. These conditions seem to give the best results when burning refuse and a small amount of coal. When burning coal only nearly balanced draft conditions are carried.

In connection with the construction of this boiler, we had planned the installation of a very elaborate system for drying the wet bark. We have, however, rejected the idea because after 3 mo. operation of the new burner, we find that it is not necessary.

Developments in Coal Cleaning Processes in Britain

By C. H. S. Tupholme

THE STRESS of war and the resulting period of Government control, says Robert Nelson, of the Institution of Civil Engineers, have had a definite and adverse effect on the quality of the product of the coal industry. That coals of all kinds have deteriorated in respect of the amount of incombustible material to be found in them will be denied by few suppliers and no users. The small or slack coals commonly used for industrial purposes are the worst offenders.

"Unscreened small" is the class of coal generally used by the large electricity works throughout England, and from 40 separate records where a comparison of the ash in pre-war and post-war coal can be directly made, the average increase in the quantity of ash is nearly 63 per cent. That is to say, coal which formerly contained 8 per cent of ash now contains on the average 13 per cent.

It has been said that nearly 90 per cent of the coal used for industrial purposes is unwashed. Coal washers of varied design whose advantages and limitations are well known have been in use for many years, but there are two processes of recent development, one of which has the added interest that it is new in principle.

The chief difficulty in coal washing by the older methods is to deal effectively and efficiently with fine coal. The process just referred to as being new in principle offers a solution of this problem. The other process, on the other hand, attains an unusually high degree of efficiency in dealing with coals of all sizes from 2½ in. downward. A proper combination of the two would seem to offer an adequate solution over the whole range of coal cleaning.

The new process of washing coal is entirely independent of specific gravity methods. The coal to be treated, if not already fine enough, is crushed until the particles pass through a screen about 1/10 in. linear aperture. It is then mixed with three or four times its weight of water together with a small quantity of reagent. The reagent may be an oil or coal-tar product, and 1 lb. is, generally speaking, required for each ton of coal treated. The mixture is agitated by a power-driven mechanical mixer and a multitude of minute air-bubbles are produced. To these air-bubbles the coal particles attach themselves and they are floated by them to the surface of the water in the form of a thick coal-laden froth. The ash-forming dirt sinks to the bottom. The coal contained by the froth is removed by a suitable scraper and then dried for use. The dirt which sinks is drawn off and rejected.

Once the proper reagent has been found, the working of the flotation process is extremely simple and very effective.

Apart from piping and valves and the mechanically driven mixers and scrapers, the ordinary flotation machine is constructed entirely of wood. It consists usually of from five to ten "mixing" boxes, each with a "froth box" connected to it. The material under treatment passes from mixing box 1 via froth box 1 to mixing box 2, thence via froth box 2 to mixing box 3 and so on through the plant, the final reject coming from the last froth box.

A flotation machine to deal with 1000 tons of coal in a 24-hr. day measures approximately 37 ft. by 15 ft. 9 in. by 15 ft. 6 in.

The following typical separation was effected recently in the cleaning of Derbyshire Top Hard Slack:

	Weight Per cent	Ash	Fixed Carbon	Volatile Matter
Crude	100.00	29.55	48.2	22.35
Cleaned Product...	75.1	9.86	60.24	29.9
Reject	24.9	82.45	2.75	14.8

The new process for cleaning coal other than "fines" comes to England from Belgium. It is called the Rheolaveur process, its main features being:

1. The means used to carry the material to be washed through the washer, namely, a stream of water confined in a series of narrow troughs.
2. The simple arrangement by which the process is controlled.
3. The arrangements by which part of the material under treatment is automatically rewashed so that, in the ultimate result, a high degree of freedom from shale and dirt is attained.

A strong and steady flow of water is the first requirement of the process. The water is turned into a trough into which the coal to be treated is also led. The flow of water carries the coal along with it and the separation of the coal and dirt is effected by stratification, the rate of flow of water being so regulated and the trough of such a length as to allow time for the coal and dirt to stratify. Arrangements are made to draw off the dirt from the bottom of the trough at intervals, allowing the coal to be borne along until, at the end of the trough, there is no more dirt to draw off and clean coal is delivered to the clean coal hoppers. At each drawing-off point a cast iron box is inserted and a current of water (controlled by a hand valve) is made to flow upwards from the bottom of the box into the trough to prevent coal from being drawn off with the dirt; serving a similar purpose to the upward flow of water in the washbox of the Draper washer. The water is stored in a tank fixed about 20 ft. above the trough and arranged to give a steady continuous flow of water.

In washing nut size the strength of the upward current of water in the first box is kept high so as to allow shale only to be drawn off. This shale forms the reject and it finds its way at once to the shale dump. In the second box the strength of the upward current of water is rather less so as to allow the balance of the shale, and it may be a little coal, to pass through the box. This reject is not sent to the shale dump; it is returned by means of an elevator to the original trough to be rewashed. In washing nut sizes two boxes only are necessary, the coal passing the second being dirt free; it is delivered therefrom via a moving drainage plate to the nut coal bunker.

In washing small coal four boxes and two lengths of trough, one above the other, are necessary, but the principle of working is the same.

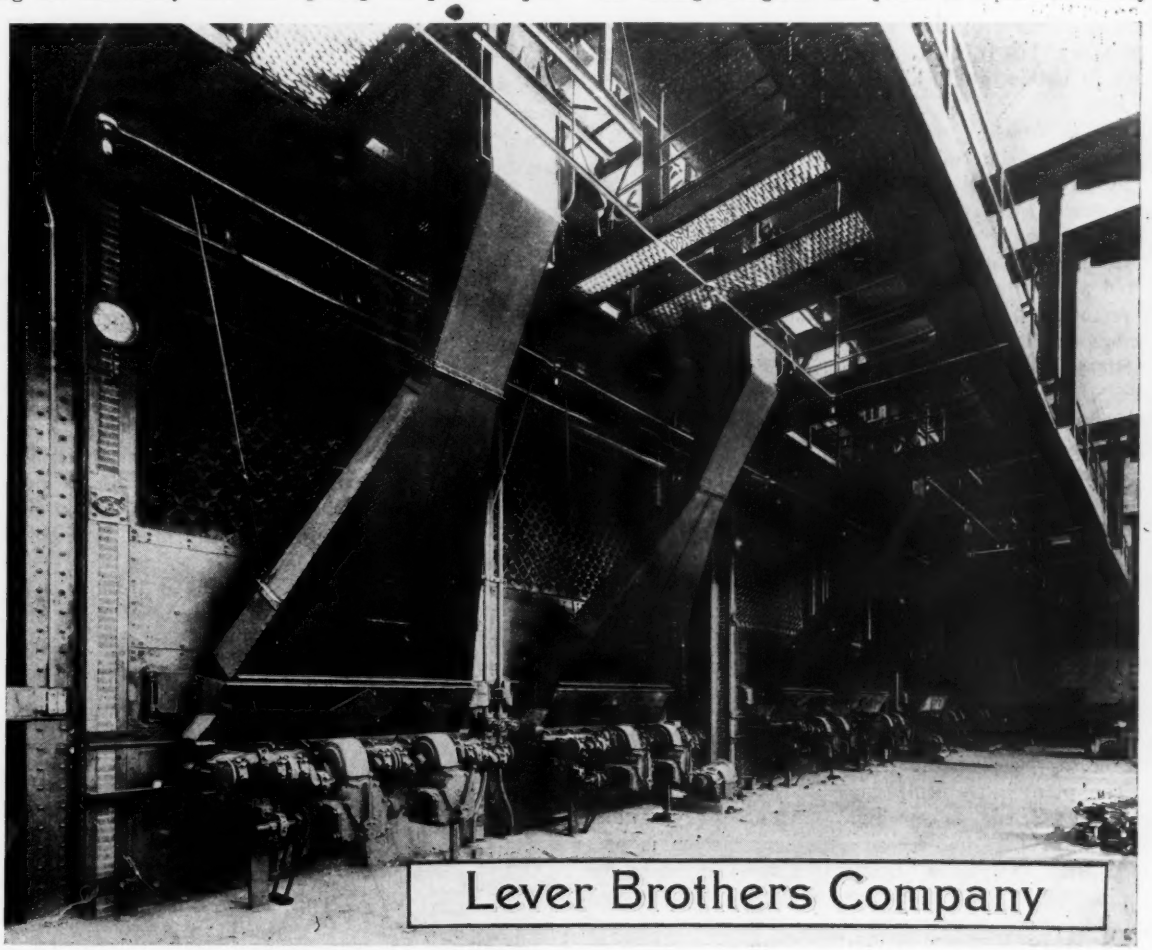
Wage cost for anthracite coal has increased during 4 yr. from $1.70 a ton to $4.20 a ton.

Superheated Steam for Heating Only

THE 3000-HP. BOILER PLANT OF THE LEVER BROS. CO. GENERATES HIGH PRESSURE STEAM FOR INDUSTRIAL PURPOSES ONLY

RECENTLY THERE has been installed in the plant of the Lever Bros. Co. in East Cambridge, Mass., a new battery of high pressure boilers which are used only for heating. This company is in the business of making soap and glycerine, for the production of which a considerable quantity of heat is required. Heat must be supplied and at a high temperature, hence the high pressure boilers.

At the present time all power required for operating the machinery and for lighting the plant is purchased from an outside source, but it is thought that in the future it will prove more economical for the plant to generate its own power.



BOILER ROOM OF THE LEVER BROS. CO. PLANT

The present power plant is concentrated in a boiler room in which there are six new Edge Moor horizontal water-tube boilers arranged in groups of two along the length of one side of the room. They occupy only half of the building; the other half is clear, but is to be used for another battery when the need for more capacity makes the installation of more boilers necessary.

Each boiler is rated at 500 hp. and is ordinarily operated at that capacity, which gives a total output of 3000 hp. At peak loads, however, or when one or more units are off the line, the steaming power is increased in one or more of the remaining boilers, as much as 100 per cent with but little loss in efficiency.

Normally the battery is operated two or three shifts, that is, 16 or 24 hr. per day, during which time the average coal consumption is about 4 T. per hr. or 64 T. per day of 16 hr.

Coal is delivered from the track hopper beneath the siding alongside the plant to a bucket conveyor which elevates it to a position over the coal bunker from which it is passed onto a belt conveyor which travels the length of the hopper. A movable dumping device serves to lay the coal in any desired section of the bin.

This bunker is constructed of steel plate with a concrete lining and formed to an hyperbolic cross section. The whole is suspended from above. It has a capacity for 1100 T. or enough for a run of about 17 days.

From this bin the coal is spouted down to the stoker hopper on each of the six boilers and is automatically weighed en route. The scales consist of a bucket with a drop bottom in which the coal falls until there is a

certain predetermined weight on this side of the scale. When the balance point is reached, the scale tips and closes an electrical contact which starts a motor which acts to close the gate in the down spout from the bunker; at the same time the bottom of the bucket falls and the coal spills out into the spout which carries it to the stock hopper.

Each furnace is equipped with a Riley, six retort, underfeed stoker which is driven by a chain and sprocket from a line shaft below the boiler room floor. The shaft is ordinarily driven by a geared down turbine, but it is also geared to a motor which is used in starting up from cold boilers or in case of an emergency.

The furnace operates under an approximately balanced draft. Air under pressure is supplied under the grate by a Sturtevant blower, geared to a Terry turbine. A chimney, 175 ft. high, serves to create the necessary draft to obtain practically atmospheric pressure over the fire.

Ash is dumped over the end of the grate into a hopper under the boiler room floor. This basement is on the ground level and it is therefore an easy matter for a truck to drive in under the hopper and receive a load of ashes.

On account of the fact that the refuse has to be carted a considerable distance from the plant, the cost of removal is an item which makes the purchase of a more expensive low ash coal economical.

Steam is generated at a pressure of 175 lb. per sq. in. gage. A Foster superheater between the first and second passes superheats the steam 100 deg. to a temperature of 478 deg. F.

A counter flow economizer is provided which raises the temperature of the feed water from 212 deg. to 295 deg. and at the same time the flue gas temperature is reduced from 500 deg. to 300 deg., a temperature only 5 deg. above that of the water entering the boiler.

The returns from the factory are mixed with the make-up water and enter the Swartwout open feed water heater at a temperature of about 100 deg., which varies up and down with the amount of water returned from the factory. In the heater the temperature of the water is raised to 212 deg. and fed to the economizer by a turbine driven centrifugal pump.

The plant is carefully operated, consequently the operating efficiency is kept high. As a necessary adjunct to keeping operating records, the boiler room is provided with CO_2 recorders; temperature recorders for keeping tab on the temperatures of the flue gas entering and leaving the economizer of the feed water, in and out of the heater and at both ends of the economizer and also the temperature of the steam; and an indicating and recording steam flow meter.

U. S. Civil Service Commission announces examinations as follows, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at the salaries indicated, and vacancies in positions requiring similar qualifications, at these or higher or lower salaries: Technologist, $2800 to $4000 a year; Associate Technologist, $2000 to $2800 a year; and Assistant Technologist, $1500 to $2000 a year. Apply for Form 2118, stating examination title.

A Fire Cleaning Method; Saving Packing

By Jack L. Ball

BOOMER sat in the boiler room door and watched the fireman laboriously clean two fires by the old "kick over" method. After a short rest, the fireman opened one door of No. 3 boiler and ran the heavy slice bar into the side of the fire, intent upon repeating a slow, laborious operation that he had been following for years when Boomer interrupted:

"Just a minute, you don't mind if I pull that fire for you?"

The fireman readily consented and gave Boomer his blouse and gloves. Several shovelfuls of coal were thrown on the fire against the bridgewall. Boomer sat down, with:

"Some firemen have an idea that the 'kick over and clean one side' method is about the only way that a hand fired furnace can be perfectly cleaned. This method is slow, admits too much cold air to the furnace, too much fuel is lost through the grate bars into the ashpit, and it takes too much time."

He picked up the hoe, or scraper, opened a fire door part way and began to push the live fire back to the bridgewall; he did the same with the other side of the fire. The ash and clinkers were then pulled out, the grate bars being absolutely clean in front of the live coals at the bridgewall. The fire was pulled forward from the bridgewall and coaled, this method requiring but half the time of the other method. Cleaning a fire this way must not be confused with the one whereby the front half of the grates are raked clean. the fire pulled forward and the clinkers on the rear half of the grates pulled out over the top of the clean fire. It is obvious that the latter method is wrong.

"A nice arrangement," continued Boomer, "is to have a space of about 18 in. between the ends of the grate bars and the bridgewall. This will give you plenty of room to shove your fire back on."

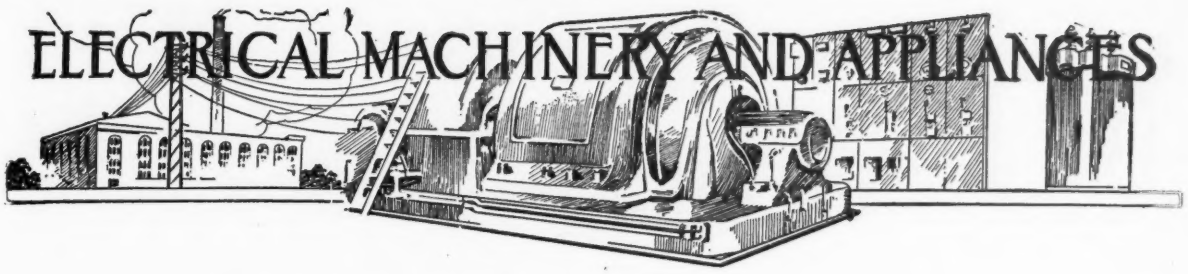
The engineer who had been a silent listener to this conversation invited Boomer into the engine room. Walking over to an engine he began:

"The stuffing-box on this engine can surely swallow packing and packing costs money. It takes eight rings on top of the packing ring to fill it up."

"I operated an engine once," began Boomer, "with a 2 13/16-in. rod that took seven rings of ⅝-in. square packing. I took accurate measurements and molded a babbit ring—not lead—that took up just the space of three rings of packing. This worked very satisfactorily and the four rings seemed to hold just as tight and lasted just as long as the seven rings did. The life of packing is limited and when it hardens and begins to leak, it is time to renew. Simply adding a ring when needed is a mistake and will cause trouble in the end, usually by scoring the rod."

The writer had instructions one time to repack completely the valve and piston rods on a triple expansion Corliss pumping engine. "A ring when needed method" had been freely used for a long time and the old packing had to be drilled out!

The wages of idleness is demotion.—Forbes Magazine.



Protection of Electrical Equipment---I

DISCUSSING SOME OF THE TRANSIENT PHENOMENA IN ALTERNATING CURRENT CIRCUITS AND MEANS OF PROTECTING AGAINST ABNORMAL CONDITIONS. BY H. W. SMITH*

IN THE supply of electric energy, whether it be from a central station to the surrounding district, or from a large power plant to one industry alone, continuity of service is under modern conditions of production essential.

In many cases the greatest loss is not due to the loss of the sale of power during the shut-down or the cost of repairs to damaged apparatus, but to the loss of product under manufacture which is spoiled by the interruption of the supply of power.

As the size of the electric system increases, the troubles multiply, and in our large central stations and industrial plants it requires much thought and careful maintenance to give a service compatible to the requirements.

It is, therefore, timely to discuss the best means of protecting electrical apparatus and securing an uninterrupted flow of energy.

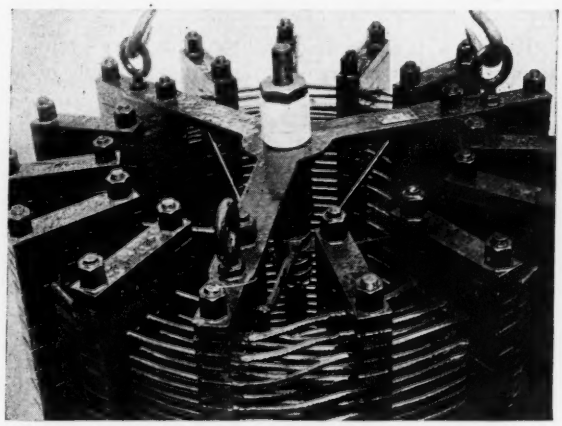


FIG. 1. SINGLE-PHASE CURRENT LIMITING REACTOR

Under present conditions all large generating systems generate three-phase alternating current, and our remarks, except where otherwise indicated, will apply to alternating current systems.

Trouble in electrical equipment is generally caused by either excessive current or excessive voltage. Excessive current will produce both excessive mechanical stresses and overheating, while excessive voltage will often break down the insulation. Taking up first the cases under which excessive currents are produced, let us first consider a short circuit on an alternating current generator.

SHORT CIRCUIT ON A. C. GENERATOR

THE SHORT circuit current of a generator is limited by armature self inductance and armature reaction. When the current flows in the armature the conductors become encircled by lines of force. These lines may be divided into two groups. The lines which pass through the magnetic circuit have an effect called armature reaction. The lines which do not pass through the magnetic circuit are called leakage lines or self inductive flux. The short circuit current produces a local magnetic flux in the armature iron and pole faces which does not interlink with the field coils, but is a true self inductive flux and can be represented by a reactance X. The current in the armature is lagging and produces a demagnetizing effect, and has the effect of reducing the resultant flux, and hence the generator electromotive force. The armature reaction, however, requires an appreciable time to develop since the field flux cannot change instantaneously, as it interlinks with the field exciting coil and any change of the field flux generates

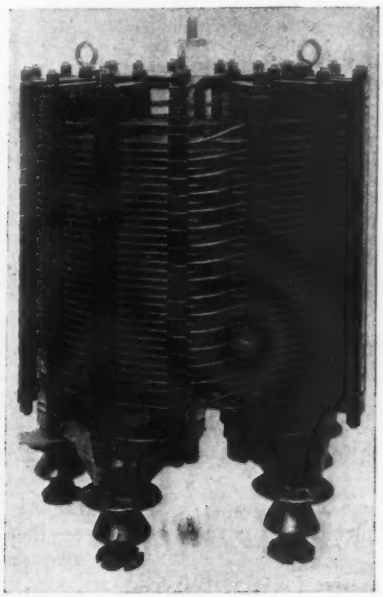


FIG. 2. METHOD OF SPACING END TURNS OF REACTOR WINDING

*General Engineering Department, Westinghouse Electric & Manufacturing Company.

an electromotive force in the field coils, changing the field current so as to retard the change of the field flux. Hence at the first moment of short circuit the short circuit current is only limited by the armature reactance and is equal to electromotive force divided by the armature reactance.

It is customary to specify reactance in terms of the percentage drop of voltage when full load current is

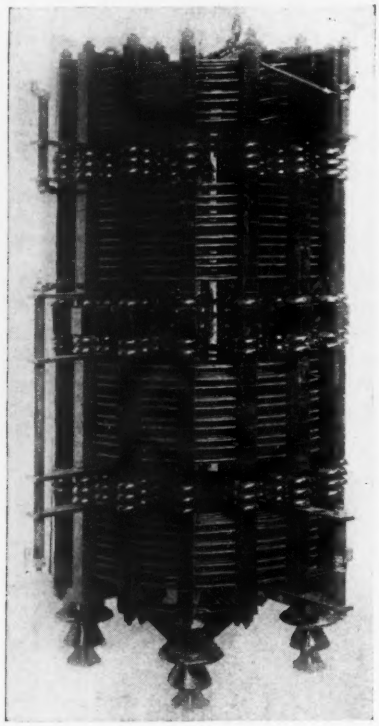


FIG. 3. THREE-PHASE REACTOR FOR 25-CYCLE, 66,000-V. CIRCUIT

flowing. For instance, 10 per cent reactance means that at full load the drop across reactance = 10 per cent electromotive force.

$$\text{Now short circuit current} = \frac{\text{electromotive force}}{\text{reactance}}$$

$$= \frac{\text{electromotive force} \times \text{full load current}}{\text{reactance} \times \text{full load current}}$$

$$= \frac{\text{full load current}}{\text{per cent reactance drop}}$$

Therefore, 10 per cent reactance means $\frac{100}{10} \times$ full load current.

At the moment of short circuit, it is also possible to have an unsymmetrical condition which may give a value twice the above, but this dies down very quickly. The mechanical stresses on the coils depends on the square of the current, so that if the short circuit is ten times full load current the stresses are 100 times the normal stress on the coil.

In all modern machines, the coils are braced on the end windings to resist these stresses, but it is very essential that such bracing be carefully inspected to see it is kept rigid. If any movement of the coils occurs under short circuit, it is very likely that the insulation at the junction of the straight part of the coil with the end winding will be damaged. Though the insulation may not break down immediately, it will be a weak spot and when any excessive voltage occurs, such, for instance, as when an arcing ground occurs, the insulation on the generator may break down.

It is possible, however, to get greater currents than that obtained by short circuiting a machine. Suppose for example, we have a machine running on the bus, of reactance X, and a similar machine is switched on 180 deg. out of phase; the resultant current $= \frac{2E}{2X} = \frac{E}{X} =$ short circuit current of one machine. If, however, two machines are on the bus, and a third machine is switched on, the resultant current $= \frac{2E}{X+X/2} = \frac{4E}{3X} = 1.33 \times$ short circuit current of one machine. With three machines running, and a fourth machine switched on the resultant current $= \frac{2E}{X+X/3} = \frac{1.5E}{X} = 1.5 \times$ short circuit current of one machine. With an infinite number of machines on the bus, the resultant current for a machine switched on 180 deg. out of phase $= \frac{2E}{X} = 2 \times$ short circuit current of one machine.

Hence, a mistake in synchronizing may result in mechanical stresses greater than those which obtain when a machine is short circuited.

Other conditions may give excessive currents. For instance, where there are a number of gas engine generators, and back firing occurs, the machines get out of step and large currents flow. The continued application of the mechanical stresses on the coils, due to these currents, may distort them and weaken the insulation so that they break whenever any excessive voltage occurs.

A case in point is a large steel mill where four 2000-kw., 85 per cent power factor, 3-phase, 25-cycle, 6600-v., 7½ per cent reactance, 36-pole, gas engine driven generators are installed. From Jan. 1 to June 11, generator breakdowns occurred, three at times of feeder grounds, three when back firing occurred and two when synchronizing. An inspection of machines showed the long ends of the coils distorted ¼ in. to ½ in. out of line. Oscillograph tests were made to find the angular displacement between generators and cross current flowing. It was found that when there was no back firing, the swings of cross current were equal to full load current and during back firing currents as high as five times full load were recorded. As these machines have 7½ per cent reactance, the instantaneous short circuit current is 13 times full load; but in about one-half second this would drop to four or five times full load current. The swinging occurred at about ½ sec. intervals. These

machines therefore had mechanical stresses equal to 25 times full load stresses applied whenever back firing occurred and the continued application evidently weakened the coils. Bracing of the coils to render them rigid corrected the trouble.

Reactors

In order to limit the rush of current when a short occurs, current limiting reactors have been used considerably during the past 5 yr. The main reasons for the use of reactors are:

1. The protection of generators from the mechanical forces due to short circuit currents.
2. The protection of circuit breakers and bus structures.
3. To minimize the reduction in voltage due to a short circuit and hence to prevent synchronous apparatus from falling out of step.

In general, reactors may be installed in the feeders, in the generator leads, or in the bus between generators.

Feeder reactors have the following advantages:

(a) They limit the short circuit current to a definite value so that a serious disturbance is not caused.
(b) Smaller feeder circuit breakers can be used.
(c) The amount of current fed back by synchronous apparatus in the feeder when trouble occurs in the station is limited.

They have the disadvantage of requiring considerable space and do not protect against short circuit on the bus or the generators.

Generator reactors are usually used where a machine has low reactance to limit the current which can flow under short circuit. They also, in the case of a failure of a generator, limit the current which can flow from the other machines into the damaged machine.

When reactors are placed in the bus bars, they should permit parallel operation under normal conditions even with considerable exchange of energy between sections, while under short circuit conditions on any section they should limit the current rush to a value such as not seriously to interfere with the operation of the other sections.

The current limiting reactors, built by the Westinghouse Co., are cylindrical coils with horizontal layers wound radially, the bare stranded copper cables being supported at intervals in non-inflammable cleats cold molded under high pressure. Tie rods of treated hickory clamp the coils together. The whole is mounted on extra heavy pin type insulators, so designed as to put the porcelain under compression. One terminal is brought through the top and one through the bottom, thereby giving a maximum separation between terminals and providing a symmetrical arrangement usually well adapted for connecting to the busses or feeders.

Additional refinements are to increase the spacing between the conductors at the ends of the coil and between the end layers and the body of the coil and to eliminate all soldered joints by the use of brazed or clamped connections. Figure 1 shows an up-to-date reactor which is rated at 100 v. and 1000 amp. for a 3-phase, 25-cycle, 11,000-v. circuit, while Fig. 2 shows in detail the method of spacing the end turns of the winding.

Reactors are usually single-phase, one coil being used for each phase.

The three-phase type of coil with the three-phase mounted co-axially above one another was developed by the Westinghouse Co. Coils of this type are adapted for feeder circuits where the current does not exceed 300 or 400 amp. They are especially adapted for underground feeders as the cable limitations just about coincide with the limitations in the reactor. The three-phase type offers considerable saving in floor space with a relatively small increase in head room required. Figure 3 shows an up-to-date design being rated at 127 v., 400 amp. per phase and is used on a 3-phase, 25-cycle, 6600-v. circuit.

In the installation of reactors, several points have to be borne in mind. The reactor depends on air for insulation, so that a reactor should not be installed in a location where steam or dust are present. They reach high temperatures under short circuit conditions since their heat storage capacity is small. All magnetic material should be kept a certain distance away from the reactor, otherwise heating will be caused due to eddy currents caused by the magnetic field of the reactor.

Mechanical stresses occur between reactors, but when the adjacent reactors are separated by one-third of their diameter, when side by side, and one-half of their diameter when co-axial the mutual forces due to short circuits are within safe limits and external bracing between reactors will not be required. This rule applies only to three reactors on a three-phase circuit and is in terms of diameter over copper and separation from copper to copper. The arrangement which should especially be avoided is that where adjacent reactors may simultaneously carry short circuit currents in phase with one another.

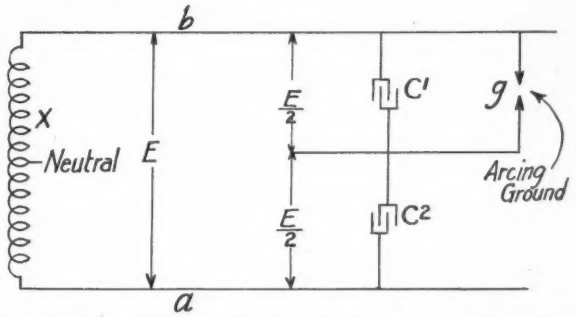


FIG. 4. SIMPLE EQUIVALENT CIRCUIT CONTAINING AN ARCING GROUND

Current Transformers

In very large plants, it is necessary to pay attention to the current transformers. Air cooled transformers have both mechanical and heating limits, and in general should not be used where the short circuit currents can exceed 40 times the full load rating of the current transformer.

Excessive Voltage

Having considered some of the results of excessive currents, let us now devote our attention to the question of excessive voltages.

Every electric circuit may be viewed in two ways. It may be regarded as a closed circuit containing resistance and inductance and carrying a certain current

produced by a certain electromotive force, or it may be regarded as a large insulated condenser. The circuit, therefore, performs a double function. It transfers useful energy and at the same time acts as an electric condenser. When a current is flowing through a circuit containing inductance, energy is stored in its magnetic field. The amount of this energy equals one-half the product of the inductance and the square of the current. This energy was obtained from the circuit when the current was started, and when the electromotive force producing the current is removed, must be discharged back into the circuit before the current can stop. If the circuit be opened suddenly, a very high potential will be developed to keep the current flowing until this energy is fully discharged. Such is the case of the well known rise of potential which results from suddenly opening the field circuit of a large generator.

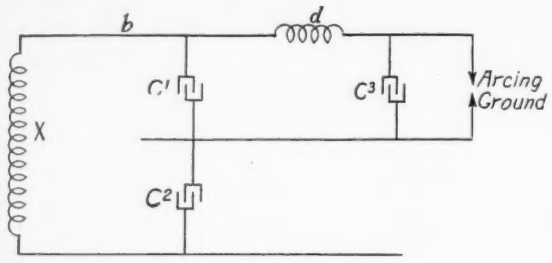


Fig. 5

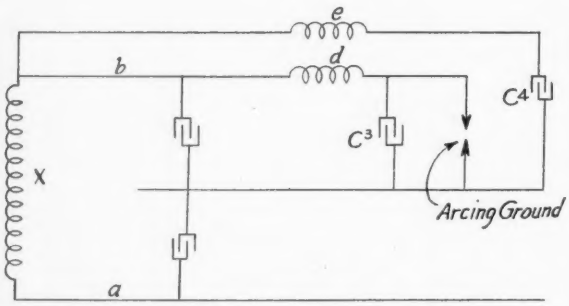


Fig 6

FIG. 5. EQUIVALENT CIRCUIT IN WHICH TWO SETS OF OSCILLATIONS ARE SET UP BY ARCING GROUND

FIG. 6. SHOWING HOW INDUCED OSCILLATIONS ARE SET UP IN NEARBY CIRCUITS

Also when a condenser is charged, energy is stored. This energy will be restored to the circuit again when the condenser is discharged. The amount of this energy is one-half the product of its electrostatic capacity and the square of the voltage. The energy of an electric current may thus be stored in two ways. Either in a magnetic field produced by a current or in the electrostatic field of a condenser. In its former state, the energy may be regarded as kinetic and in the latter as potential.

When a condenser discharges suddenly through an inductive circuit containing comparatively little resistance, the current in the discharge path increases steadily until the condenser is completely discharged. At this time the current in virtue of the magnetic field which it produces, stores nearly the full amount of the energy originally in the condenser, for there is little waste as the resistance assumed is small; but this current cannot become zero until all its energy is discharged into the circuit, which, in this case, means into the condenser. Therefore, the condenser is charged to its original voltage again, but this time in the opposite direction. At the instant all the energy is thus restored to the condenser, the current is zero; but the condenser cannot remain charged with the discharge path closed and will discharge again repeating the same phenomena, thus the charge oscillates backward and forward through the discharge circuit. If the resistance is not zero, a little energy is lost every time discharge occurs, so that each time the condenser is charged to a lower potential than the preceding time until the whole energy is finally transformed into heat.

If now a condenser be charged through an inductance, energy will be steadily stored in the magnetic field produced by the charging current until the condenser has reached full potential. All this energy must be discharged into the condenser before the charging current can cease; that is, if there are no resistance losses, the condenser will be momentarily charged to double potential. The condenser will then oscillate between double potential and zero until it finally settles down at the potential of the circuit from which it is charged, which occurs only as the oscillations are damped by the resistance of the current or by other losses. These phenomena may be made clear by mechanical analogy.

The first case of the discharging condenser is similar to that of a pendulum which has been drawn aside and released. It oscillates about its final position of rest until its energy is all expended in friction. The second case may be compared to a weight supported by a spring. If the weight is dropped, it will descend beyond the point at which it is finally to come to rest stretching the spring to twice its final extension. The weight will then be drawn up again beyond the point of equilibrium, oscillating backward and forward until its energy is dissipated by friction. The inertia of the weight corresponds to the inductance of the circuit, and the elasticity of the spring corresponds to the capacity of the condenser.

As an application of these principles, let us examine what happens on a non-grounded three-phase system when an arc or spark discharge to ground occurs.

Arcing Ground on Non-Grounded System

For the system operating with the neutral ungrounded, the conditions that exist in the circuit may be more clearly explained by the use of a simple equivalent circuit as shown in Fig. 4. We can represent the windings of the generator, transformer or other source of power as a resistance x, for simplicity, shown as single phase. C_1 is the capacity of one conductor to ground and C_2 the capacity of the other conductor to ground. In three-phase systems, conductor a would correspond to two conductors.

A ground occurring on one conductor as at g would discharge one condenser C_1, while condenser C_2 would be charged to a potential corresponding to E. This is double the initial value and would result in a flow of charging current through the reactance X of a value

due to the increase of $\frac{E}{2}$ in the voltage across the condenser. The flow of this current through the reactance will cause an increase in potential approximately equal to the increase in potential across the condenser C_2, the conductor a being raised approximately to a potential $3E$ — above ground. The current and voltage will then oscillate until a steady condition is reached corresponding to the potential E.

As the neutral of the system is not grounded, the only current flowing through the arc from b to ground will be the charging current of the line, and as the arc is in parallel with the condenser C, it is unstable. The reason for this is that in an arc the voltage across the arc must increase when the current decreases. Now as the voltage E_1 decreases, the current through the arc decreases. This will mean an increased drop across the arc, so that more current will flow through the condenser C_1. This still further reduces the current in the arc until finally the arc goes out. When this occurs, a second oscillation is caused between C_2 and X and the conductor B is raised above the normal value of $\frac{E}{2}$ above ground. When E_1 reaches the necessary value to break down the gap, the arc is re-established and results in another train of oscillations.

The establishment and quenching of the arc may occur many times in one cycle of the 60-cycle wave, and at each breakdown, the oscillations are set up. When the oscillations are set up successively so fast that one cannot die them out, before the next occurs, it is possible to have them so add to each other that the potential of the line to ground can build up to enormous values. If the neutral of the generator is grounded the current flowing to ground in case of a breakdown of insulation would be of much higher value and determined by the reactance and resistance in the ground circuit rather than by the capacity of the cable. The arc then becomes stable, because of the generator reactance and it will not be successively established and extinguished.

Only the simplest case is considered above, but in practice many complications may arise.

For instance in Fig. 5, C_1 and C_2 represent the capacity of one conductor and two conductors of the system to ground. C_3 and d represent the capacity and reactance of a single feeder from the main bus. If an arcing ground occurs on this feeder, two sets of oscillations are set up, one between C_2 and x, and the other between C_3 and d. Again, suppose there are feeders running close to the one on which breakdown occurs as shown in Fig. 6, when an oscillation occurs through d, an induced oscillation will occur in e and this induced oscillation acting in a circuit made up of reactance e and condenser C_4 may cause a high potential along this feeder and results in a breakdown.

UNDER A co-operative arrangement between the Bureau of Mines and the Southern Appalachian Coal Operators Association of Knoxville, Tenn., work has been begun on the sampling of coal from mines in Tennessee and eastern Kentucky.

A Safe Method of Turning Down Commutators

BY W. B. DEMUTH

TURNING DOWN the commutator is often the easiest way to stop sparking, for the time being at least. If a rough commutator is the cause of sparking turning it down is the proper procedure when sandpapering or grinding will not suffice. It should always be borne in mind, however, that every time a commutator is turned down the capacity of the machine is reduced for a given temperature rise.

Ten years ago machines were liberally designed; a 500-kw. synchronous converter could be operated at 750 kw. continuous. Today design is very close because of competition and the overloads and abuse that once were feasible are today dangerous to the life of the machine. The temperature of the commutator depends upon the heat generated in it and the ability with which the heat

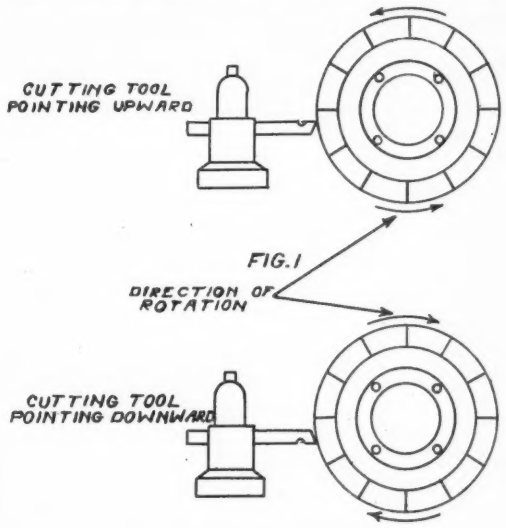


FIG. 1. TURNING DOWN COMMUTATOR WITH CUTTING TOOL POINTING UPWARD

FIG. 2. TURNING DOWN COMMUTATOR WITH TOOL POINTING DOWNWARDS

can be dissipated. Every time a commutator is turned down, which means that anywhere from 1/64 in. to 1/16 in. is taken off the circumference, its current-carrying capacity is lowered; and its temperature rise thereby increased for a given load. This fact does not mean much for a machine that is turned down once every few years; but it means considerable when a machine has its commutator turned down every few months, a common condition where the service is severe.

The writer has always followed a definite policy in turning down commutators. That this is a wise one was proved by a recent accident which resulted from failure to adhere to this policy during his absence. The machine in question was a large motor having a commutator of about 8 ft. diameter. This commutator, the most costly part of the machine, had become rough under severe service and it was determined to turn it down during a week-end; this was done. Two cuts are always

advisable in turning down a commutator; the first is a real cut, the second merely for the purpose of smoothing off the surface. As the finishing cut had reached about halfway across the commutator, which was about 2 ft. in width, the cutting tool dug into the commutator, digging a gash about ¼ in. deep out of the center. The commutator was also subjected to a severe shock. Had this commutator been turned down in a safe manner, such an accident could not have happened.

In machine work, the metal being cut in the lathe invariably turns downward toward the cutting tool, which invariably has its cutting face pointing upward. When a commutator is turned down and the commutator is large, a slide rest from a lathe, or similar tool is generally installed upon the frame or bed plate of the machine and the armature is belt driven so that the commutator can be turned down with minimum disturbance to equipment. The arrangement generally used is shown in Fig. 1, but is unsafe as the writer will show. The only safe arrangement is the one that is followed by the writer and which is shown in Fig. 2.

With this arrangement of the cutting tool, there is absolutely no chance of the tool "digging in." If the slide rest moves, vibrates or jams, the tool is thrown away from the commutator instead of being forced to cut into the commutator as is the case with the arrangement shown in Fig. 1. With the writer's arrangement, the tool is installed upside down and the direction of rotation of the commutator is reversed. If this method were more widely followed, many of the severe injuries to large commutators would not occur.

To minimize the effect of the injury, the commutator was turned down for a space each side of the cut to remove the burrs. Great care was taken to clean out the ragged edges where the copper from one segment was forced through the mica to the adjacent segment, as this would constitute a short circuit between coils. The holes were then filled up and the commutator sandpapered off. Before the machine was started up, the brushes were moved over so as not to pass over the section of the commutator that had been injured. The edges of the deep cut in the center of the commutator were gently beveled so that dirt would have less tendency to collect along them and cause "ring fire."

The motor in question requires turning down about every 3 mo. After it has been turned down twice more the existing groove will be flush with the remainder of the commutator surface. When this occurs, the entire surface will be turned down a minimum, the solder will be dug out of the injured segments and they will be filled up in a way that will neither interfere with commutation, with the commutator surface or the brushes. At this time, it is problematical just what will be done. It is thought, however, that either water glass will be used, or else that the hole will be drilled out carefully, tapped and plugged up. The purpose of doing this is to provide a smooth surface so that dust will not collect and which will neither roughen brushes nor cause roughening of the commutator. If the holes are tapped and plugged with copper, the plugs will be of minimum length to assure safety from being thrown out by centrifugal force and yet not so long as to go down below the surface sufficiently to injure the mica and so cause short circuit.

Oil-Injection Combustion Engines

Classes, Principles of Action and Methods of Securing Combustion. By Charles E. Lucke*

IN THE injection type engine, the fuel is thrown into the cylinder as a liquid spray, no attempt being made to vaporize it so as to form an explosive mixture. It has the advantage that it can handle any kind of fuel which is of proper fluidity to pass the pump valves and become a spray at the spraying orifice, and practically any liquid fuel can be given such fluidity by heating; but the heating must not be carried so far as to cause carbonization and cracking due to decomposition. Further, as only air is compressed, by choosing the time of injection, after compression, the compression pressure may be carried as high as desired, with resulting gain in efficiency due to high temperature combustion.

There is, however, need to get all the fuel spray into contact with air and if the injection is made too rapidly all the air charge may not be reached, especially if the combustion chamber is not of favorable shape and the injection is from a single point. If fuel is injected that cannot reach sufficient air, carbon will be formed, the engine exhaust will be smoky and the engine room become foul.

Two Classes of Injection Engines

Air must always be compressed; it may be compressed to ignition temperature and higher, so that the fuel burns as fast as injected and the rate of burning depends on the rate of injection; or air may be compressed to less than ignition temperature, the fuel injected suddenly to form an explosive mixture and the combustion be as nearly instantaneous as conditions permit. For the first, the indicator card will be as in Fig. 1, correct operation being shown by the full lines, abnormal explosions from imperfect combustion is shown by A and slow burning by B. The imperfect combustion of A may be caused by bad mixture or wrong timing of injection.

Figure 2 is a card for the second method, correct burning being shown by the full lines, a series of explosive shocks due to imperfect combustion by lines A and slow burning by B.

Neither class has an advantage over the other if both are properly adjusted, so that choice comes down to relative cost, reliability and adaptability to service needed. For the explosive class of combustion if compression pressure is about half that for the slow-burning class, efficiencies are practically the same. Compression for the explosive class must be kept somewhat below ignition value to keep the explosion under control, while for slow-burning the compression must be somewhat above ignition temperature to insure prompt ignition after injection of the fuel. For initial temperature of 250 deg. F. ignition temperature for kerosene (998

*From a paper before Boston and Worcester Sections, A. S. M. E.

deg. F.) will be produced with 150-lb. compression pressure; if initial temperature be 200 deg., 150 lb. compression will give about 100 deg. below ignition temperature, and 175 deg. initial will give 200 deg. margin below ignition. For fuel oil, of which the ignition temperature is 1070 deg. F. at compression to 150 lb., an initial temperature of 300 deg. will result in ignition temperature, 250 deg. initial will give 100 deg. margin and 200 deg. initial, 200 deg. margin below ignition.

To give safe margin above ignition, temperature for slow-burning injection, 200 deg. excess is considered safe for solid injection and 400 deg. for air spraying. For the latter, 450 lb. is usually used with initial temperature a little less than 250 deg. for kerosene and a little over 250 deg. for fuel oil.

Spraying Fuel

THE SIMPLEST spray nozzle is a hole drilled in a plate, Fig. 3; this gives a straight stream which is broken into spray by striking the wall of the combustion chamber. By increasing the pressure, or reducing the size of the hole, oil in the center will move faster

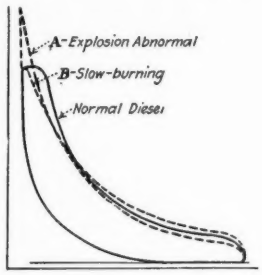


FIG. 1

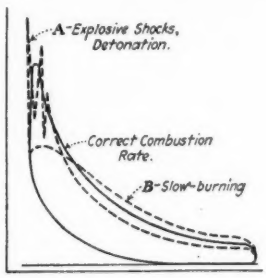


FIG. 2

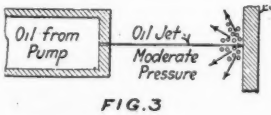


FIG. 3

FIG. 4

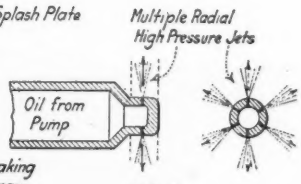


FIG. 5

FIG. 1. DIAGRAM FOR NON-EXPLOSIVE, OIL-INJECTION ENGINE
FIG. 2. EXPLOSIVE COMBUSTION DIAGRAM
FIG. 3. HORNSBY JET SPRAYED BY PLATE
FIG. 4. JET SPRAYED BY HIGH PRESSURE
FIG. 5. MULTIPLE RADIAL SPRAY JET

than at the sides and a spray will be produced as in Fig. 4. Diffusion of the spray is needed, however, and this may be secured by several holes as in Fig. 5, or by using slots normally closed and opened by the oil pressure springing the metal. Spreading can be secured by giving the jet back of the orifice a rotary motion by means of a whirl chamber as in Fig. 6, in which orifice B should have an area greater than that of the tangential grooves so that there may be a cone effect with good penetration; too large an orifice at B will give a hollow cone, wide spread, but with no penetration into the combustion space.

Air spraying in the simplest form, Fig. 7, consists of an oil cup with a small hole at the side slightly below the oil level, and air under pressure above the oil. Air blowing across the oil surface carries a fine oil spray out with good force but not well spread. By using a nozzle of the form shown in Fig. 8 better control is obtained, the spray being delivered as a narrow cone through a contracted orifice as at A, or diffused by multiple orifices as at B. This is the "open air spray" of the Diesel engine. The "closed air spray valve," as in Fig. 9, has the air entering so as to blow oil from the surface of plates onto which the oil spreads, giving a considerable area of wetted surface. The flow is con-

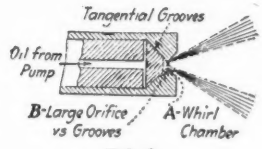


FIG. 6

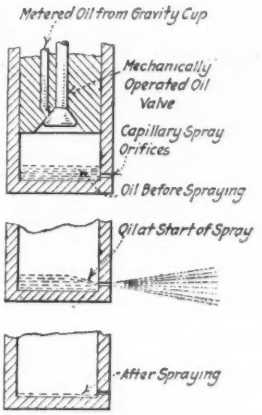


FIG. 7

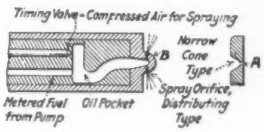


FIG. 8

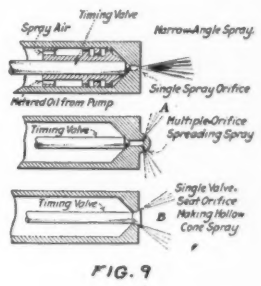


FIG. 9

FIG. 6. WHIRL CHAMBER SPRAY
FIG. 7. AIR SPRAYING CUP
FIG. 8. OPEN TYPE AIR SPRAY
FIG. 9. CLOSED TYPE AIR SPRAY VALVE

trolled by a valve which may close against an inside seat of either a single or multiple orifice as at A, or may be reversed and close against an outside seat as at B to give wider spread to the spray. Spray and combustion chamber must be adapted to each other so that the spray may best reach the air in all parts of the chamber.

Diesel Engines

THIS IS of the slow-burning air spray type with 450 lb. compression, giving a safe margin for ignition and rated at 70 lb. m.e.p. They can carry 100 lb. m.e.p. if the metal will stand the intense heat. Cylinders run up to 36 in. diam., above which there seems to be a tendency for cylinders to crack. As a compressor must be provided to furnish air of 600 to 1400 lb. pressure it is evident that for very small powers the Diesel is too complicated and expensive to be available. Fuel consumption is from 0.4 to 0.45 lb. per brake hp.-hr.

Semi-Diesel Engine

THESE HAVE the solid injection or "airless spray" which eliminates the air compressor and makes them available for small powers. Hot metal is utilized to help vaporize the fuel and to assist ignition. This

hot-metal combustion chamber may be a fire risk and involves some likelihood of breakage; also the temperature is difficult to keep within the desired limits. Hot metal chambers of various forms and in different locations are used for different makes, the Hornsby type being shown in Fig. 10.

Solid-Injection, Cold-Wall Engine

Two types are in use, with explosive combustion and with non-explosive. One example of the former is the Ingersoll-Rand arrangement, Fig. 11, in which a fine spray is injected into the conical chamber A from two sides. Air compressed in the cylinder is forced into space B, mixing with the spray, and reaching ignition temperature just before the end of the stroke. Misfires at light or no load are avoided by an air throttle which acts to retain enough of the hot burned products of exhaust to insure ignition temperature. Pre-ignition

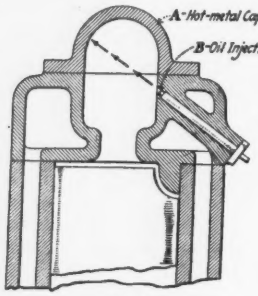


FIG. 10

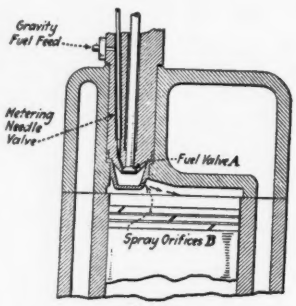


FIG. 12

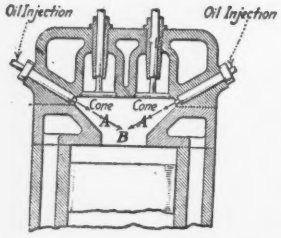


FIG. 11

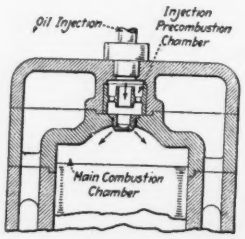


FIG. 13

FIG. 10. HORNSBY COLD WALL COMBUSTION CHAMBER
FIG. 11. INGERSOLL-RAND COLD COMBUSTION CHAMBER
FIG. 12. HVID ENGINE COMBUSTION SYSTEM
FIG. 13. WORTHINGTON DIVIDED COMBUSTION CHAMBER

from overheating of the air charge may be avoided by later injection of the fuel. Such engines use a compression of 200 to 250 lb. pressure.

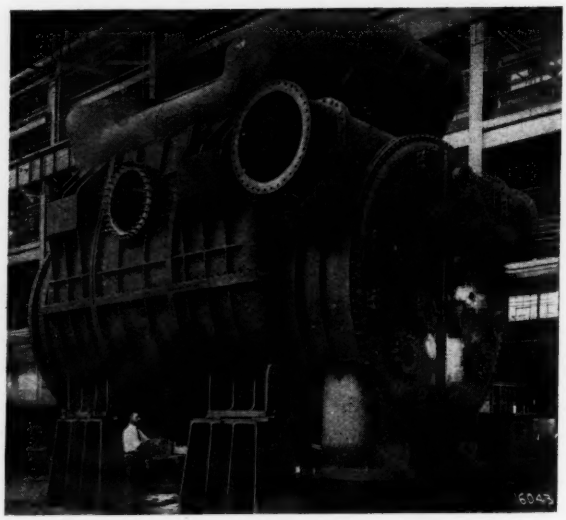
Several cold-wall, slow-burning engines have been developed in Europe, and in the United States the Hvid engine has been developed for small powers. As shown in Fig. 12, this has a fuel cup into which the fuel flows by gravity past a metering needle valve and fuel valve A, reaching the cup before compression begins. During compression, air flows into the cup through holes B, which are small enough so that this inflow of air will prevent the outflow of oil. At the end of compression, pressure in the cup is less than in the cylinder, but as the piston moves forward and cylinder pressure is lowered, air will flow out of the cup, spraying the oil through holes B which results in slow-burning in the cylinder. Size and number of holes must be chosen so that oil will not flow out during charging, yet the air requirement seems to limit the Hvid engine to small sizes, as a large charge of fuel is difficult to handle in this manner.

Divided Combustion

To avoid the necessity for accurate timing and prevent detonating shocks, some designers divide the main combustion chamber into two parts, one in the cylinder and the other separated from it with narrow passages connecting the two. The American development of this type is the Worthington, Fig. 13, in which oil is injected into the precombustion chamber by a pump. The central tube, supported from the side walls by a web perforated with large holes constitutes a fuel guard to limit the air coming in contact with the fuel. As the amount of air in the precombustion chamber is small, but little of the fuel is burned there, avoiding explosive shock; the rest will gasify or vaporize, and the rise in pressure will force it through the small passages into the main combustion chamber. Outflow of fuel is helped by lowering of pressure in the cylinder due to the forward motion of the piston, much as in the Hvid engine. Parallel flow of fuel and air streams results in a burning similar to that of a Bunsen burner.

Large Condenser for New Power Station

THERE has recently been shipped for the Hellgate Station of the United Electric Light & Power Co., New York City, the first of two 50,000-sq. ft. condensers built by the Westinghouse Electric & Manufacturing Co. at its South Philadelphia plant. This condenser took six cars to haul, the entire shipment weighing 129¼ tons. The illustration shows the divided water box feature of the condenser which permits taking



SHOP VIEW OF CONDENSER SHELL FOR HELLGATE STATION

one-half of the condenser out of service while the other half is being cleaned. Each condenser requires two circulating pumps, which are rated at 35,000 g.p.m. each, and are driven by 350-hp., 295-r.p.m. motors. Each condenser is served by a Westinghouse-LeBlanc air pump and Westinghouse condensate pumps.

Trouble Hunting

By John Pierce

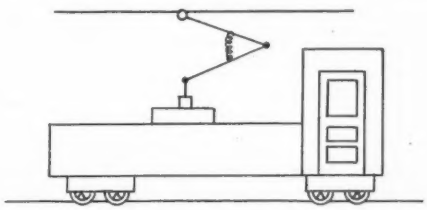
ONE OF the many things which troubled the worthy master mechanic, at my place of business, was the accounting for the consumed current generated. It was mostly guess work, and the entire system had to be checked over, as regards the meters, so that a correct charge could be made against the various departments; and to satisfy the general offices in New York, this all had to be figured on the basis of the *apparent* amount of current consumed, owing to the fact that not a single one of the 100 meters was in calibration, and but one of the 30 main meters at the house checked up right.

I secured a pair of new ammeters and volt meters by the simple means of having a new set sent me and then borrowing a record set. I also received a new main output meter and after putting it on the board proceeded to check against it. I found that, checking the new volt meters against each other, I could get the right voltage. Then I proceeded to test the new ammeters by checking them in the same way, and by my calculations of volts and amperes I found the new output meter to be correct. I had now established a base upon which to work and proceeded to "work over" the meters.

The electrician told me that he'd never needed a "bridge" or, in fact, any other type of testing apparatus, and that he knew nothing of testing meters; but he was above the average Mexican in intelligence, and assured me that he wanted to learn and to learn all that I could, and would, show him. So I started in to act the missionary and preach the gospel of electrical science. I admit that I do not know a great deal about the business myself but I was glad to do what I could for my dusky brother. It was amusing, however, to have him ask me to promise not to tell his men that I was teaching him, for he had them trained to eat from his hand and to think he was a sort of second Edison, and he didn't want the charm broken. I told him I'd not expose him but would do all I could to hide his felony.

In going over the meters I found, I think, every standard make, and some that weren't, in the world. All of them were all the oldest of old timers. One had no real distinguishing marks on it, but from its appearance I rather think that it was the one old man Noah turned in after he grounded his ship and dismantled her. The only way I could do was to put up a series of switches, with a series of banked lights, irons, and heating apparatus, ranging from about 60 v. to a 100-amp. load. I had, strung along the ceiling of the shop, some thirty-odd arc lamps, and along the walks I had the incandescent lamps, while on the benches were the heating apparatus, and on the floor a brine solution with my terminals running into it. Yes, and I was cut in on an old resistance that I borrowed from an old switchboard. I had my ammeter on the line and my voltmeter across it. I found on the inside of the case of each meter the number of revolutions each disk had to make in order to perform a certain duty. Among the many meters listed I think that the old "Siemens" was about the easiest one to "set up" and "work over" that I found. I would, in most cases, find that I had only to adjust the meters with the regular adjustments provided for the purpose. With a known voltage and amperage it was only a matter of an instant's calculation to determine what wattage I should get, and then to try my meter, ranging from nothing to 100-amp. load.

I found one meter that was inclined to want to creep "forward" and two which had a tendency to creep backward. Some had weak magnets and, having no way to strengthen them, I had to open the counter coils and cut in a loop so that the coils would perform their functions in accordance with the magnets. Some had to have other things done to them, and all had to be cleaned. I found one large recording meter that would not perform at all as it should and as its resistance was made up of a series of three sets of coils, each separate from the other, I chopped one of them entirely off. The meter had not been running fast enough by about 20 per cent, but after chopping off this coil she speeded up to beat the band and ran much too fast. I moved all her adjustments for a slower speed, but



I SIMPLY MADE A DOUBLE JOINTED POLE THAT LOOKED LIKE THIS

found I could not get them over far enough to do the required amount of work. So I began a little experimenting and found, finally, that common iron hay baling wire did very well for the work I expected of it. I made a nice little coil of about 20 ft. of this common baling wire, insulating each turn from the other turns, and then made it fast in my line of resistance. By doing this, I found it slowed the meter down entirely too much, but by cutting it off, an inch at a time, and checking the meter, I finally got it to the point where all the different instruments checked.

During these days I had purposely not looked at the meter reader's reports—we took meter readings each morning at seven o'clock—nor had I tried in any way to ascertain how my newly calibrated meters were checking with the output meter. The following day, however, after the last meter had been gone over and put back on the line, I was much gratified to have the assistant superintendent tell me that he found that the distribution sheet of consumed current checked almost exactly with the power house's report of current generated and that no guessing had been at all necessary. The small difference we charged to loss in railbonds, etc., and everybody was happy, but I think the happiest man was the chief electrician.

While we had been testing the meters I, noticing the conglomeration of load building apparatus which we

had gathered together, decided to try an experiment in electric welding. I told my chief electrician about it, and carefully explained the way I had read of this work being done, had seen a little of it, but not much, and as we had acetylene welders on the work, we decided to try to fit up an electric welder, using the apparatus on hand to build up the amperage. So, securing himself a 5-gal oil can, the chief fixed himself a tin hat with a red light, or window, in front. We then rigged up a well insulated handle and tried out our machine. It was a queer thing to see those arc lights jumping and spluttering and hear them hissing and sizzling. We found that we could do a little welding, but it was not at all satisfactory. I began to hunt for more load to add on, for I was almost sure that this was our trouble, and as there was nothing else quite satisfactory, we swiped some of the apparatus from the hospital. The best we could get was 125 amp., but we could do quite a little work and what we did was very good. The only thing about it was that it was strictly not a "portable" outfit, and the heat from the arc lamps spoiled it, for my office was directly overhead, and it made it too hot for me. It showed up so well, however, that the superintendent ordered a portable machine which came after I left, and which has given the best of satisfaction.

Our next move was the construction of a trolley pole which, though serving its purpose, was a peculiar looking affair. The "pole," as it was, had a socket set up in the center of the electric motor car directly over the motors and in this socket was a hinged pole, which could go from side to side, and turn completely around in case of necessity. Certain changes made in the construction of the sheds under which these electric engines worked, called for the moving of the trolley wire several feet higher. Of course a longer "pole" could be used, but this would not do, as the buildings were so designed that backing on through to the last set of switches, to cross to the other tracks, the longer pole rammed the walls, as the wires at this point could not be raised.

There was some difficulty experienced in changing the pole before reaching this point and letting it reach back over the cab. Also, with the longer pole, in returning from the line to the station, the engines had to be driven with the poles forward instead of slanting back, as traveling under the lower trolleys out on the line the pole, when set back, would strike the cab. Therefore we had either to lower the cab, which was not practical, raise the entire line, which was expensive, or design a new pole. Uncle John got busy with his thinker and resolved to fix it. As a result, after a few experiments that either failed altogether, or that proved worse than the old pole, the following was designed, put into operation, and proved successful. I have not had it patented, for it may be already patented; I will only say I never saw one like it before. The only reason I think it may have been is that "great minds, etc," and so some other "great mind" may have beat me to it.

I simply made a double jointed pole that looked like this sketch—I warn you beforehand that she's not drawn to scale. Now laugh. I laughed myself—but say, fellers, she sure do do the work. Notice the spring I put in up there at the new end? I'll say she's all right.

I'm about ready to leave here and go to that other new job I spoke about, for by now my 90 days are up. Excuse me, please, while I go back to my "turkey."

South Meadow Station

(Continued from page 1184)

brick and concrete chamber has water sprays in the uptake at each side, air passing over the generator and down the middle passage. As an alternative, by changing the damper setting air may be drawn from the turbine room and discharged into that room or into the suction chamber of the forced-draft fans. This permits using generator air in winter to heat the turbine room and reduce roof condensation by throwing down excess moisture as the air is cooled in passing the water sprays. To maintain positive pressure in the turbine room, 20,000 cu. ft. per min. of outside air will be forced into the room by ventilating fans located in the room shown in Fig. 5.

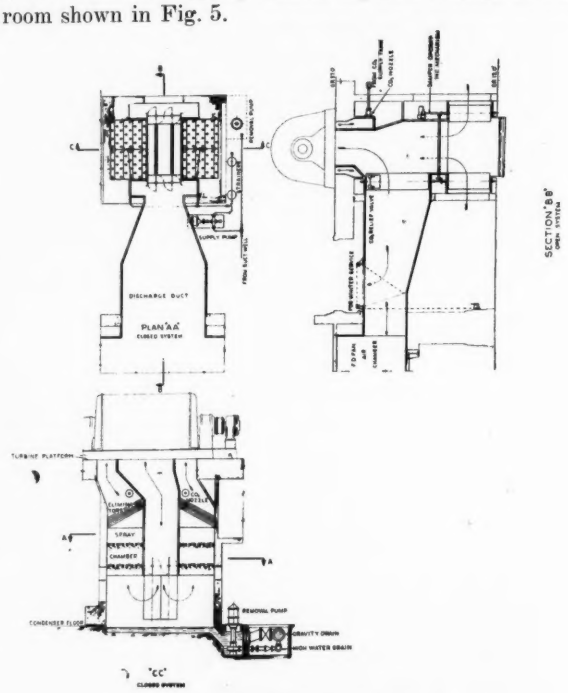


FIG. 9. GENERATOR COOLING SYSTEM

Damper control of the generator cooling system is interlocking by means of gears and is operated by a motor for quick change from closed to open system in case water pressure for the sprays is lost. River water is used, supplied by a motor-driven pump and normally removed by gravity, but a removal pump is provided at one side of the drain pit for use during high-water periods.

Elimination of dust deposits from air drawn from outside is secured by the closed system of generator cooling, thus reducing fire risk; also the supply of air to support combustion is reduced, and in addition a system of gas smothering of fire is provided. Carbon dioxide, purchased in containers at 2000 lb. pressure, is stored in a steel tank as a gas at 200 lb. from which pipes, with necessary drains and valves, lead to nozzles at points in the air uptake to each generator, just below the inlet to the generator. In case of fire, the CO_2 is turned into the generator casing to smother combustion, the extra pressure opening dampers into the duct leading to the forced-draft fans. This flushes out the air

from the generator casing, and when pressure decreases after CO_2 admission is stopped, these dampers will close.

Rheostats for control of generator and exciter fields which are placed on a gallery directly under the turbine platform at the end of each generator are electrically operated by remote control motors. Just inside the building wall, next to No. 1 unit rheostats is a room containing the resistor for the neutral ground bus, and the resistor short-circuiting switch. The neutral connection for each generator is brought through the air duct into its rheostat room, a current transformer inserted, and connection made through an oil

cables for mains, two 1,250,000 cir. mil., neutral 1,000,000 c.m., fields 500,000 c.m. exciter armature 750,000 c.m., and exciter field No. 4.

For the 30,000-kw. units—37,500 kv.a. at p.f. 0.8—switches are provided in the mains for 3000 amp. Bus bars are three 3 by ¼-in. strips and cable connections for the mains two 2,000,000 c.m., for exciter armature 1,250,000 c.m. and exciter field No. 2.

In the completed station will be two 11,000-v. busses on either of which all circuits of that voltage may be paralleled, but the present installation is one such bus. This is three 4 by ¼-in. strips to carry 37,500 kv.a. and

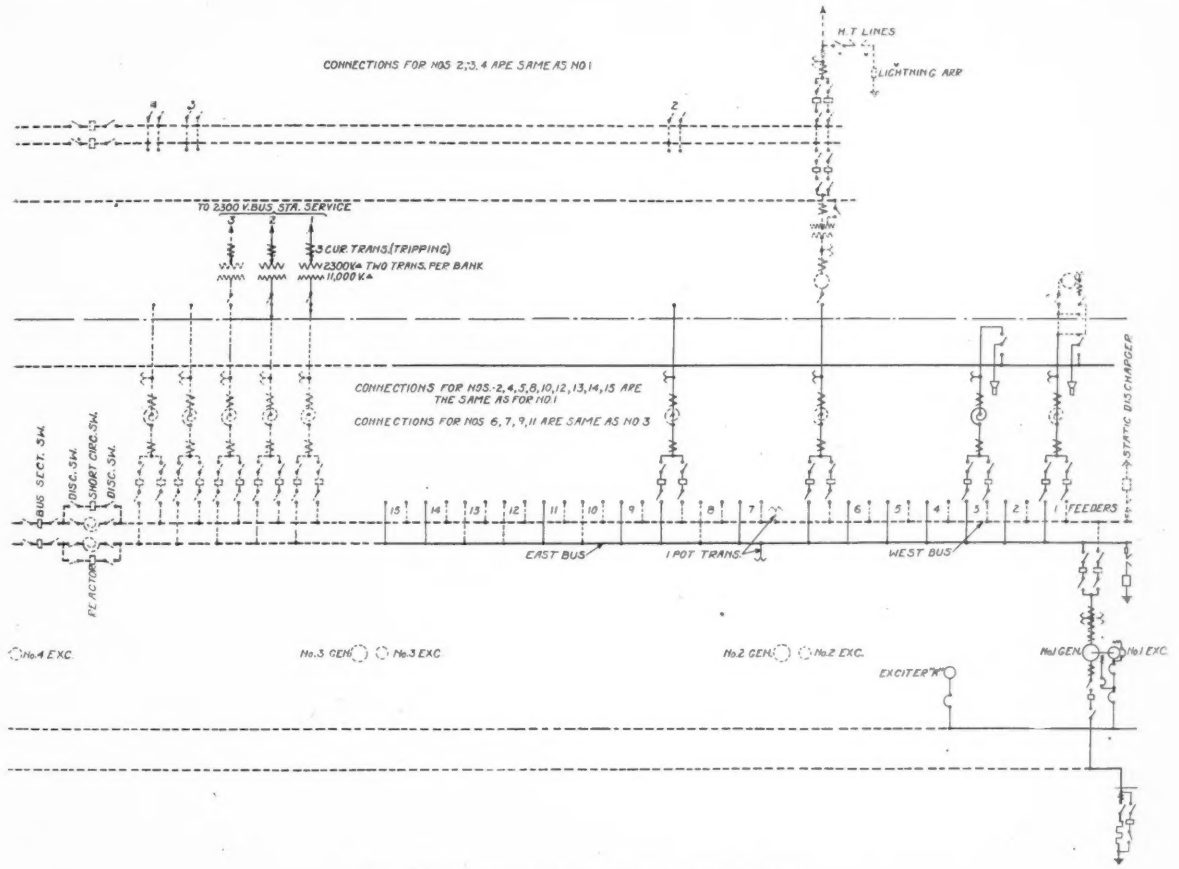


FIG. 10. CONNECTION SCHEME FOR STATION

circuit breaker to the neutral bus which is carried in a conduit beneath and the length of the turbine platform.

Electric Connection System

Simplicity, safety, ease of operation and of future change and extension have been the considerations in laying out connections. Present distribution will be largely at 11,000 v., but in future may be at 66,000 v. or higher, with interconnection to other large stations or transmission systems. Figure 10 gives the connection scheme for the 11,000-v. system, exciters and neutral grounding. The 20,000-kw. units have a rating of 25,000 kv.a. at 0.8 power factor, exciters being 100-kw. Circuitbreakers are provided for 1600 amp. on the generator and 500 amp. on the feeders and circuits of like capacity, the neutral switch being for 1200 amp.

Bus bars are two 3 by ¼-in. strips and connection

will have switches and reactors for 3000 amp. Each circuit is planned to have a reactor also but for the present they are provided only in the tie lines to the Dutch Point station, circuits 3, 6, 7, 9, 11, on Fig. 10. These are designed to give 15 per cent drop at normal current rating, but in other feeder circuits the reactors will be designed for 3 per cent drop. If necessary, reactors may also be placed in the main generator circuits.

Two high-voltage lines are now provided with 7500 to 12,000 kv.a. capacity each and four lines are planned for 22,000 kv.a. each, circuit breakers and switches for 1500 amp., cables to be 1,500,000 c.m. Temporary connections are now made for lines 1 and 2 as shown in Fig. 11. As all 11,000-v. feeders are run underground, no provision is made on them for lightning arresters, but an oxide film static discharge is installed for each 11,000-v. bus. Feeders are for 250-amp. capacity with 500-amp. circuit

breakers, 400-amp. current transformers, 300-amp. switches and cables 350,000 c.m. The feeder busses are 2 by ¼-in. strips.

Station Service

Standard voltage for station motors is 2300 for 50 hp. and larger, smaller capacity motors taking 220 v.

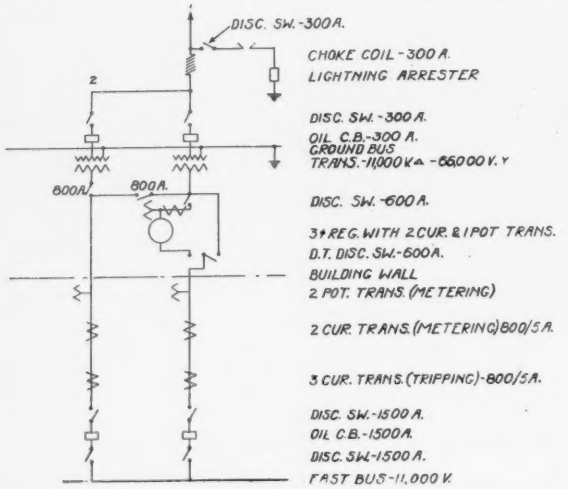


FIG. 11. TEMPORARY CONNECTIONS FOR HIGH-TENSION LINES NOS. 1 AND 2

the 11,000-v. side of No. 00, on the 2300-v. side 1,400,000 c.m. and 2 by ¼-in. strip for bus bars. These transformers are temporarily fed by a direct connection from feeders 14 and 15. They will later have a 2300-v. ring bus divided into three sections with all important service lines having connections to each section, any two of which can carry the entire load.

Details of station service are shown in Fig. 12, which shows also sizes and capacities of cables, switches, motors and instruments. For the 220-v. motor service two banks of transformers 2300-230 v. will eventually be needed for turbine room and electrical bay auxiliary power, and like equipment for the boiler house, but present equipment is half that in each place. Each bank has three 150 kv.a. transformers supplying busses for the leads to auxiliary motors. Circuit breakers are used in motor circuits except a few of 2½ hp. or smaller which are protected by fuses so arranged that blowing of a fuse in one phase will open the other phases. Disconnect switches on each side permit of isolating all 2300-v. oil circuit breakers for inspection and overhauling.

Station transformers are outdoors alongside the electrical bay with control of the 11,000-v. side on the main switchboard. A truck type switchboard under the electrical bay, Fig. 5, controls the 2300-v. side as well as all 2300-v. auxiliary circuits. Near these transformers is the 2300 to 220-v. bank for the electrical bay

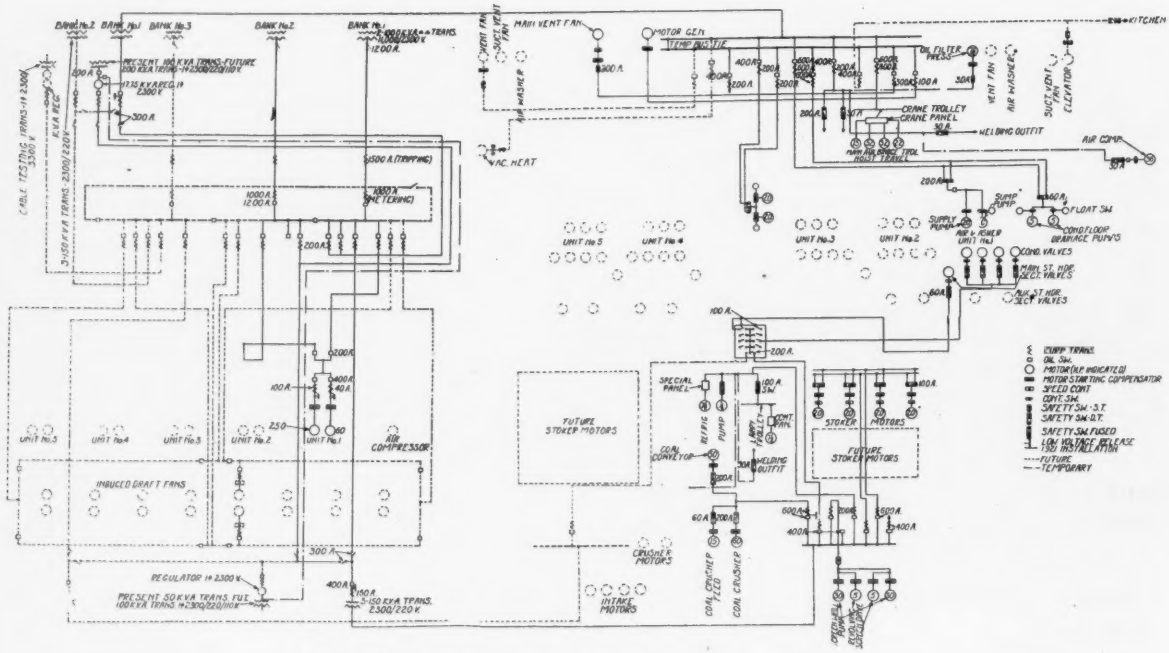


FIG. 12. DETAIL CONNECTIONS FOR STATION SERVICE

Three banks of 11,000 to 2300-v. transformers, any two banks being able to carry all station auxiliaries, are planned. Each bank will have three transformers, 1000 kv.a. each, single-phase self-cooled and connected delta-delta. Present equipment is four such transformers connected in open delta-delta in two banks, either of which can carry the installed auxiliaries. Circuit breakers are provided for 500 amp., current transformers for 200 amp., switches for 300 amp. and connecting lines on and turbine room, the 220-v. side being carried to a switchboard in the room with the 2300-v. board. Boiler house power is controlled by a bank of transformers and switchboard in the basement, shown on Fig. 5.

Lighting

Ample general illumination is provided in the boiler house and turbine room with special local light at stokers, water columns, instruments, valves and stair-

ways. For the boiler room heavy duty fixtures are used with cast-iron outlet boxes and hoods, steel reflectors and porcelain sockets so arranged that smoke and fumes cannot reach the interior. For the ash room and

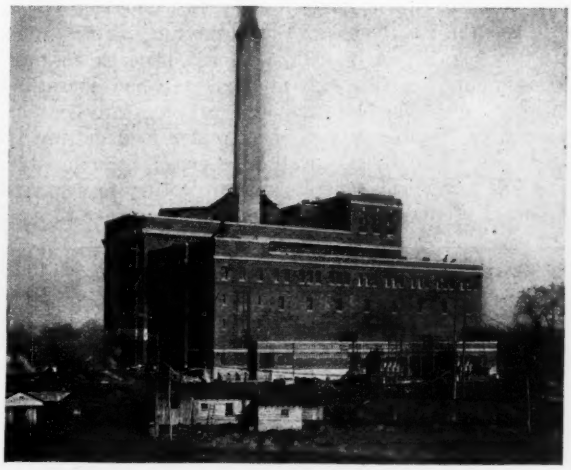


FIG. 13. PRESENT STATION BUILDING FROM RIVER SIDE

similar locations, vapor-proof fittings are used with heavy guards. In the turbine room, industrial type fixtures are used. Current is furnished from 2300-220-110-v. transformers in a room off the electrical bay, Fig. 4, control being from panels in convenient locations. In case of trouble on the a.c. circuits, sufficient lights to permit safe operations of the station are automatically thrown on the station battery, and the emergency lights circuit in the main switchboard room is always connected to the battery.

Reactor and bus rooms which have only artificial light have circuits normally operated from panels at

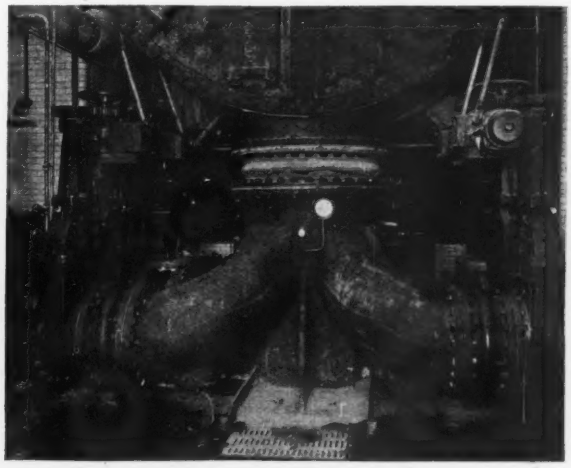


FIG. 17. CONDENSER CIRCULATING WATER CONNECTION

the ends of the rooms, so that one must enter the room to turn on the light; but an emergency circuit is controlled by a hallway switch just outside the door so that the operator can turn on these lights and view the room through a wired glass panel before entering.

FIG. 14. FIRING AISLE IN BOILER ROOM. FIG. 15. TURBINE ROOM FROM ABOVE SHOWING FIRST UNIT. FIG. 15-A. TURBINE ROOM FROM OPENING TO CONDENSER FLOOR

Busses, Reactors and Oil Circuit Breakers

Each bus is contained in a compartment built up of precast concrete slabs so arranged that they never carry

more than their own weight, and is supported on special bracket insulators designed so that, in case of a short circuit, stresses between busses will always put the porcelain in compression. The porcelain has a white glaze to render dust conspicuous. The main supporting wall serves as a barrier to the passage of gases between bus compartments and circuit connections, access to the bus being only from the passage between the bus structure and the outer wall, with all openings covered by asbestos doors. Insulators for 11,000-v. circuits are of post type, with white porcelain bodies designed to collect a minimum of dirt and make that noticeable.

partment. Potential transformer compartments are along the outer station wall in the reactor room, two transformers being installed per circuit, each with two fuses having series protective resistors to limit the current, and consequent gases when a fuse blows.

Above the bus rooms are the oil circuit breakers, with disconnect switches in compartments beneath so that the attendant has full view of breakers when operating a disconnect. This location also prevents any gas or flame from opening a disconnect under load getting to the busses. The division wall between adjacent breaker cells has a vertical concrete rib projecting to separate the doors of these cells and prevent the passage of con-

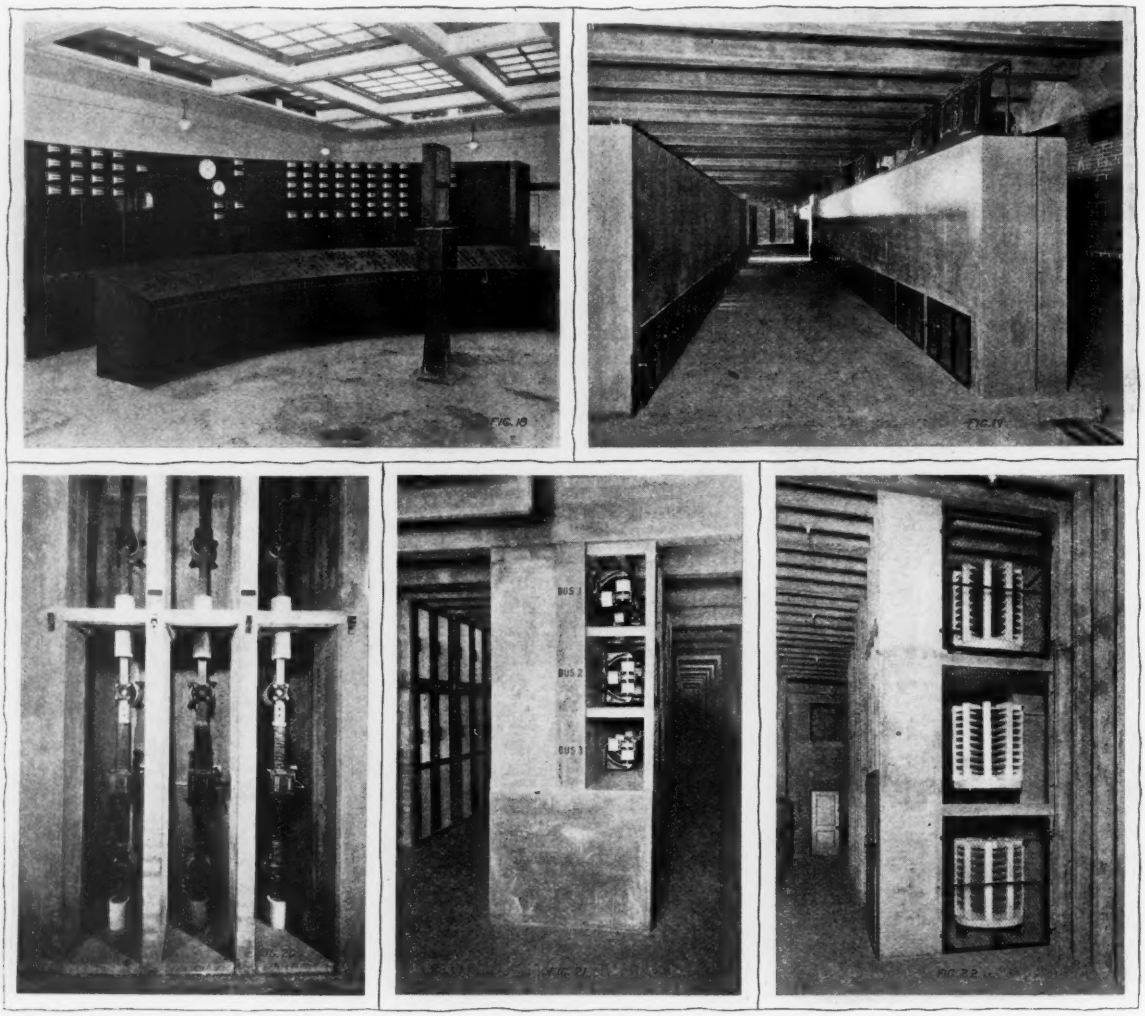


FIG. 18. MAIN SWITCHBOARD AND CONTROL BENCH, WITH GENERATOR SIGNAL PEDESTAL IN FRONT. FIG. 19. 11,000-V. OIL CIRCUIT BREAKERS; DISCONNECT SWITCH COMPARTMENTS BELOW. FIG. 20. RELAY CURRENT TRANSFORMERS, 11,000-V. CIRCUITS. FIG 21. 11,000-V. EAST BUS SHOWING SPECIAL INSULATORS. FIG. 22. 250-AMP. REACTORS IN COMPARTMENTS

Beneath the bus rooms are compartments, one for each reactor, the three for each circuit being in a vertical line, and those for adjacent feeders being staggered either side of the central division wall, Fig. 4, giving easy ventilation and room for inspection and cleaning. The structure is of concrete, the compartments of concrete brick with concrete shelves and grounded metal grill doors on each side of each compartment.

ducting gases from one cell to another directly under the cell doors. In the ceiling over each breaker is an insert for an I bolt to be used in discounting the breaker when necessary. Windows give ample opportunity for ventilation of the room to outside air and the space around breakers and artificial ventilation provide for rapid dissipation of any gases which may be generated within the breaker cells.

Tap and drain sink at one end of the room, connected to filter press and oil banks in the oil room provide convenient means for filling the cells with clean oil.

Storage Battery

The battery is in a room at ground level in line with the cable house, Fig. 4, having at present sixty 150-amp.-hr. cells, half the ultimate installation. Ventilation is by louvers in the outside wall, an outside door allowing bringing of acid directly into the room. A lead-lined sink with water tap provides for cleaning and refilling jars, the floor being treated with oil and paraffin to prevent damage from acid and all steel work being covered with acid-proof paint.

Cable House

This is at the side of the electrical bay at ground level, Fig. 2, and is so designed as to permit, within a section, connection of any feeder circuit to any underground cable; that is, any cable can be brought to any feeder oil circuit breaker, all cable crossings being separated by tile duct wall and 2 in. of concrete. Circuits leaving the building come down to pot heads directly over the duct lines in the cable-house basement, where double-throw switches above the pot heads allow an underground cable to be connected, by one throw to the bus circuit, and by the other to the ground bus.

Access to the cable house is either from the electrical bay or from the outside so that men working on the underground system need not enter the station. Additional circuit breakers can be installed, if found advisable, in each of the outgoing circuits directly above the cable house.

High-Voltage Lines

As the station may in the future be used to feed a high-voltage network, space has been reserved on the

Principal Equipment

No. in first installation	Kind of Equipment	Type	Size	Manufacturer
4	Boilers	Bigelow-Hornsby water tube	13,920 sq. ft. 275 lb. press.	The Bigelow Co.
4	Economizers	Steel-integral	2750 sq. ft.	The Bigelow Co.
4	Superheaters	Foster	6250 sq. ft.; 225 deg. superheat	Power Specialty Co.
4	Stokers	Riley underfeed	16 retort, extra long; 286 sq. ft.	Sanford Riley Stoker Co.
4	Stoker drive	Steam turbine-geared silent chain	20 hp.	Terry Steam Turbine Co.
4	Stoker drive	Induction motor	20 hp.	General Elec. Co.
2	Forced draft fans	Turbo-vane, driven by steam turbine-geared	200,000 c.f.m.	B. F. Sturtevant Co. Westinghouse Elec. & Mfg. Co.
2	Feed water heaters	Open	540,000 lb. per hr.	H. S. B. W.-Cochrane Corp.
4	Soot blowers	Diamond	20 units	Diamond Power Spec. Co.
1	Coal storage crane	Locomotive	20-ton; 50-ft. boom	Ohio Locomotive Crane Co.
1	Coal conveyor	Apron	60-in.	
1	Coal crusher	Double roll	130 ton per hr.	Stephens-Adamson Mfg. Co.
1	Coal conveyor	Pivoted bucket	30 by 36-in.	
1	Coal larry	Weighing	15 ton	McCarthy Bros. & Ford
2	Turbines	Curtis 23-stage	20,000 kw.	
2	Generators	3-phase 60-cycle, 11,000-volt, 80 per cent p.f. 1,800 r.p.m.	20,000 kw.	General Electric Co.
2	Condensers	Surface	30,060 sq. ft.	
4	Circulating water pumps	Centrifugal; two driven by steam turbine (geared); two driven by induction motor	18,000 g.p.m.	Westinghouse Elec. & Mfg. Co.
4	Condensate pumps	Two-stage centrifugal; two driven by steam turbine; two driven by induction motor	450 g.p.m.	Worthington Pump & Mach. Corp.
2	Air pumps	LeBlanc; driven by steam turbine		Westinghouse Elec. & Mfg. Co.
2	Air jets	Two jet; single stage		
2	Exciters	Direct connected to main unit	110 kw., 250 v.	General Elec. Co.
1	Exciter	Driven by steam turbine Gen. Elec. generator	150 kw., 250 v.	Terry Steam Turbine Co. General Elec. Co.
2	Air conditioning	Water sprays; closed system	60,000 c.f.m.	Carrier Eng. Corp.
2	Air washer supply pumps	Horizontal; driven by induction motor	500 g.p.m.	Worthington Pump & Mach. Corp.
2	Air washer discharge pumps	Vertical; driven by induction motor	500 g.p.m.	Worthington Pump & Mach. Corp.
2	Boiler feed pumps	3-stage Jeanesville; driven by steam turbine	1,000 g.p.m.	Worthington Pump & Mach. Corp. Terry Steam Turbine Co.
1	Boiler feed pump	4-stage Jeanesville; driven by steam turbine	500 g.p.m.	Worthington Pump & Mach. Corp. Terry Steam Turbine Co.
2	Service pumps	Single stage; driven by steam turbine	500 g.p.m.	Worthington Pump & Mach. Corp. Terry Steam Turbine Co.
1	Fire pump	2-stage; driven by steam turbine	1500 g.p.m.	Worthington Pump & Mach. Corp. Terry Steam Turbine Co.
2	Clean drip pumps	Vertical—motor driven	300 g.p.m.	Worthington Pump & Mach. Corp.
2	Dirty drip pumps	Vertical—motor driven	100 g.p.m.	Worthington Pump & Mach. Corp.
2	Water filters	Sand-pressure type	250 g.p.m.	International Filter Co.
2	Intake screens	Traveling	10 by 44 ft.	Link Belt Co.
2	Intake well pumps	Vertical; motor driven	900 g.p.m.	Worthington Pump & Mach. Corp.
1	Station crane	Electric bridge	5 motor; 100 ton	Northern Engineering Works
1	Stack	Concrete	15½ by 160 ft.	Heine Chimney Company

Electrical Equipment

Apparatus	Type	Manufacturer
Station service transformers	Four 1,000 kv.a., 11,000-2,300 volt outdoor self-cooled units	General Electric Co.
	Six 150 kv.a., 2,300-230/115 volt outdoor self-cooled units	General Electric Co.
	One 100 kv.a., 2,300-230/115 volt outdoor self-cooled units	General Electric Co.
	One 50 kv.a. 2,300-230/115 volt outdoor self-cooled units	General Electric Co.
	One 17¼ kv.a., 2,300-230 volt automatic lighting regulator	General Electric Co.
Protective reactors	Fifteen 250 ampere, 15 per cent drop single-phase reactors with shunt resistors	General Electric Co.
Ground resistor	One 5 ohm 1,300 ampere 1 minute cast grid resistor	General Electric Co.
Switching equipment; 11,000 volt circuits	H-9 and H-6 oil circuit breakers disconnecting switches, switchboard instruments and instrument transformers	General Electric Co.
Switching equipment; 2,300 and 220 volt circuits	Truck type switchboard with K-32A oil circuit breakers and panel boards with K-35 circuit breakers	General Electric Co.
Storage battery	One 60-cell E-15, 154 ampere-hour battery	Electric Storge Battery Co., Philadelphia, Pa.
Turbine signals and load bulletins	Operating pedestal with miniature signs and load bulletins in turbine and boiler room	Q-P Signal Co., Needham Heights, Mass.
Lighting cabinets	Double door, dead front type with tumbler switches and cartridge fuse	Benjamin Electric Co., Chicago, Ill.
Bus and cable supports	Post and bracket type; heavy duty insulators	General Electric Co.
Wire and cable	Varnished cambric and 30 per cent para rubber insulation	General Electric Co. Ohio Brass Co.
Porcelain bushings	11,000 volt floor and wall tubes	Locke Ins. Mfg. Co.
Interior lighting fixtures	Pettingell-Andrews Co., Boston; Benjamin Electric Mfg. Co., Chicago; Holophane Glass Co., Inc., New York City; Hart & Hageman Mfg. Co., Hartford, Conn.; National Company, Cambridge, Mass.	
Yard lighting fixtures	Flood lamps	General Electric Co.
Safety switches	Enclosed knife switches	Trumbull Elec. Mfg. Co., Plainville, Conn.
Terminals	Cast copper	Electric Power Equip. Corp., Philadelphia, Pa.

Additional Equipment

Kind of Equipment	Manufacturer	Kind of Equipment	Manufacturer
Stets feed water regulators	The Williams Gauge Co.	High pressure steam pipe and fittings	Pittsburgh Valve, Foundry & Const. Co.
Boiler damper control	The Engineer Co.	Low pressure steam and water fitting	Pittsburgh Valve, Foundry & Const. Co.
Safety valves	Consolidated Safety Valve Co.	Large main exhaust castings	Pittsburgh Valve, Foundry & Const. Co.
Blow-off valves—Yarway	Yarnall-Waring Co.	Holly high pressure drip system	Russell B. Hobson
Blow-off valves—Everlasting	Everlasting Valve Co.	Low pressure steam and water valves	Pratt & Cady Co., Inc.
Furnace side wall ventilation	Bernitz Furnace Appliance Co.	Atmospheric exhaust piping	Abandroth & Root Co.
Adamant fire cement	Botfield Refractories Co.	High pressure semi-steel pipe and fittings	The Lumsden & Van Stone Co.
Carborundum brick and cement	The Carborundum Co.	Cast-iron circulating water pipe and fittings	The Lumsden & Van Stone Co.
Queens Run fire brick and clay	Queens Run Fire Brick Co.	Miscellaneous cast-iron pipe and fittings	Pittsburgh Piping & Equipment Co.
Sil-O-Cel blocks	Celite Products Co.	Venturi meters	Simplex Valve & Motor Co.
Apexior boiler paint	The Dampney Co. of America	Continuous turbine oil filtration	Richardson-Phenix Co.
Smoke flues and air ducts	The Porcupine Co.	Refrigerating machinery	Automatic Refrigerating Co.
Forced draft fan and stoker controllers	The Hagan Corp.	Pipe covering	Collins-Lotz Co. (Franklin Mfg. Co.)
Surge and storage tanks	The Porcupine Co.	Ventilating sheet metal work	Dolbrook Ventilating Co., Inc.
Muntz metal condenser tubes	Chase Metal Works	Steam flow meters	General Electric Co.
Intake sluice gates and hoists	S. Morgan Smith Co.	Recording instruments	Foxboro Co., Inc.
Circulating water valves	Pratt & Cady Co. Inc.	Indicating gages	Star Brass Mfg. Co.
Rubber expansion joints	Westinghouse Elec. & Mfg. Co.	Indicating thermometers	C. J. Tagliabue Mfg. Co.
Copper expansion joints	E. B. Badger & Sons Co.	CO_2 recorders	Uehling Instrument Co.
Condenser supporting springs	Fort Pitt Spring & Mach. Co.	Master steam gage	Ashton Valve Co.
Arrow ash gates	Baker-Dunbar-Allen Sales Co.	Draft gages	Precision Instrument Co.
Atmospheric relief valves	Edward Valve & Mfg. Co.	Stoker speed tachometer	Brown Instrument Co.
Boiler stop and check valve	Edward Valve & Mfg. Co.	Heating return valves	Warren Webster Co.
High pressure steam globe and angle valves	Edward Valve & Mfg. Co.	Deactivating material	Anti-Corrosion Eng. Co., Inc.
High pressure water globe and angle valves	Edward Valve & Mfg. Co.		
Use of Sargol welded joints	Edward Valve & Mfg. Co.		
High pressure steam gate valves	Pittsburgh Valve, Foundry & Const. Co.		

land side of the station for outdoor transformers and switch equipment. At present two 7500-kv.a., three-phase, self-cooled transformers will be installed, 11,000-v. delta to 66,000-v. star, the neutral being grounded to the transformer bank. By installing a cooling system these transformers may be raised to 12,000-kv.a. capacity each.

A truck and track have been provided so that any of the outdoor transformers may be taken into the main turbine room for repairs, making the crane available for this work.

Station Control

For each main turbine a motor-operated steam admission valve is located at the point where the supply line leaves the header, and so arranged that it must be opened by hand, but may be closed by the motor, either from a control switch adjacent to the valve or by remote

control from the switchboard operating room. This room is on the top floor of the electrical bay, and contains a switchboard for the 11,000-v. circuits consisting of a double vertical panel board and a separate control bench, all of black oil-finished slate and assembled on a curve. Front panels contain the circuit operating instruments and relays, rear panels the watt-hour meters and recording instruments. On the bench are control switches and a mimic bus showing the main circuit connections.

In the floor between the vertical panels is a pull box 12 in. deep into which wiring, encased in flexible metal conduit, is brought for instruments and controls. Panel wires rise through metal floor plates to terminal boards at the bases of the panels where test links are provided for calibration of instruments.

Each generating circuit has the following instruments: 3 ammeters, indicating wattmeter, watt-hour meter with provision for printometer demand indicator, wattless component indicator, field ammeter, voltmeter, temperature indicator. On the turbine gage board is also a frequency indicator and an indicating wattmeter. A Westinghouse totalizing graphic wattmeter gives the output of all generators, and indicates in the boiler control room the total kilowatt output of all generators.

In the neutral ground circuit from the generator ground bus is a 100-amp. meter, which is automatically short-circuited if the ground current rises above that value.

On each generator panel is an ammeter and voltmeter for the direct-driven exciter and on separate panels like equipment for the steam-driven exciters.

A synchroscope is provided with switches for connecting to 11,000-v. circuits, a station clock operated by Warren synchronous motor mechanism, similar motors being used to drive all recording wattmeter charts.

Each generator circuit is protected by differential relays, operated from current transformers located at both ends of each phase winding, which trip the two main oil circuit breakers, neutral oil circuit breaker, generator field switch and turbine throttle in case of difficulty.

For each 11,000-v. feeder there is an ammeter and switch, an indicating wattmeter, watt-hour meter, and wattless component indicator. The feeder is protected by induction overload relays, one being so connected in the current transformer neutral as to trip the circuit breaker if ground current from the feeder exceeds that for which the relay is set. The four tie lines connecting to the Dutch Point plant are protected at each end by balanced relays so arranged that circuit breakers will open only in case of trouble in the tie lines. Station transformers have differential relay protection.

Primaries of the current transformers which operate relays are of bar type to give greatest ability to withstand short-circuit stresses, the transformers being located between the reactors and the busses. For circuits of less than 1000 amp. capacity, instrument current transformers are not of bar type, and are so located that the protective reactors are between them and the busses, so as to limit the flow of short-circuit current through the transformer.

In the control room is a signal pedestal from which the usual operating signals can be sent to the operating room by miniature signs on each turbine gage board. Signs on the control room pedestal show the original signal sent and a signal sent back for checking. On the pedestal is also the control for the two load-bulletin boards, one of which is on the end wall of the turbine room, the other in the firing aisle of the boiler room; and control of the emergency whistles is also on the pedestal, which thus becomes the main operating center for the steam end of the station.

Alarms for circuit breakers, transformer temperature, etc., are connected to an annunciator board on the operator's desk to keep him informed of any unusual condition in any part of the plant.

Adjacent to the main control room is the load dispatcher's desk with two miniature boards, one showing all main oil circuit breakers and station connections of the 11,000-v. and 2300-v. systems of the Hartford Electric Light Co.; the other shows all breakers and switches of the 66,000-v. stations and lines for whose operation the dispatcher is responsible. These boards, of box form, have the front curved and bear in outline the general scheme of connections, circuit breakers being indicated by holes which are lighted from within when the breakers are closed.

When breakers are open, plugs of different colors placed in the holes indicate various circuit conditions. Both boards and the telephone switchboard are so placed that the dispatcher can reach them readily without leaving his desk.

Acknowledgement is due to Stone & Webster, Inc., engineers and constructors, who furnished the data from which this article was prepared, also the blueprints and photographs used for making the cuts, and it is through their co-operation that we have been able to present this detailed description.

U. S. Civil Service Commission announces examinations as follows, to fill vacancies in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., or elsewhere, at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries: Engineer, $2800 to $4000 a year; Associate Engineer, $2000 to $2800 a year; and Assistant Engineer, $1500 to $1800 a year. Applications will be rated as received until further notice. Appointees at annual compensation of $2500 or less, whose services are satisfactory, may be allowed the increase granted by Congress of $20 a month. Applicants must not have reached their fifty-fifth birthday on the date of making oath to the application. This age limit does not apply to persons entitled to preference because of military or naval service. Apply for Form 2118, stating examination title.

Of the 9084 bona fide resident students enrolled in the University of Illinois this semester 1892 undergraduates have registered in architecture and engineering in the college of engineering. The courses offered and the number of students in each, are as follows: Architecture, 112; Architectural Engineering, 129; Ceramic Engineering, 72; Chemical Engineering, 218; Civil Engineering, 336; Electrical Engineering, 415; General Engineering, 43; General Engineering Physics, 2; Mechanical Engineering, 418; Mining Engineering, 86; Municipal and Sanitary Engineering, 10; and Railway Engineering, 51, total, 1892.

Holly Steam Loop

On page 826 of the August 15 issue of Power Plant Engineering appears the following question: "What is the steam loop and where is it used?"

As this is a question that is frequently asked by examiners for engineers' license, a more detailed explanation of the steam loop, as applied in practice, than the answer already given may be of benefit to some of the readers.

I shall endeavor to describe what is commonly called the Holly steam loop as it was applied in a certain plant where I was employed at one time.

At that time, the steam plant consisted of three 525-hp. boilers and two 600-hp. boilers, carrying a steam pressure of 200 lb. gage.

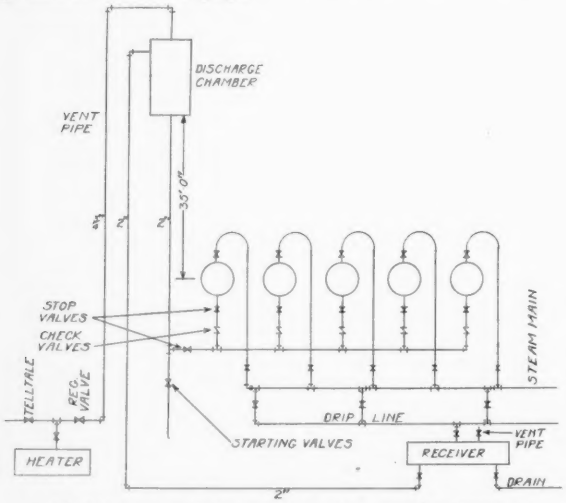


DIAGRAM OF HOLLY STEAM LOOP WHICH WORKS SUCCESSFULLY

The diagram shows the general layout of the system as applied in this plant. The condensation from the main steam line enters the receiver through the drip line and thence to the discharge chamber, which is located 35 ft. above the water line of the boilers, and flows from this chamber direct to the boilers by gravity.

The principles of operation are not difficult to understand. If a closed vessel or tank were placed above a boiler and connected to it by two pipes, one to the steam space and one below the water line, the pressure in the tank would be the same as in the boiler and water would rise in the pipe connected below the water line until it reached the level of the water in the boiler.

If a vent pipe were connected to the top of the tank and opened to the atmosphere, the pressure in the tank would be decreased and the water in the one pipe would rise high enough to make up the difference in pressure between that in the closed tank and that in the boiler, and steam will flow through the other pipe into the tank in its effort to equalize the pressure between that in the tank and that in the boiler. At the same time, any water that is held in suspension will be carried along with the steam to the tank or discharge chamber and increase the height of water in the line which is connected below the water line of the boiler and due to this increased head or height, water will flow into the boiler until the former level is reached.

For this reason, a vent pipe is connected to the top of the discharge chamber and also it takes away any air or non-condensable vapors which may collect in the discharge chamber.

To aid the operation further, check valves are placed near the boiler which prevent the water from rising to the discharge tank, and also prevent the water from passing from one boiler to the other in case of a difference in pressure or water level.

The other end of the vent pipe is connected to the heater or it may be connected to the exhaust line, with a regulator valve and also a telltale valve which discharges to the atmosphere, and is for the purpose of noting the amount of steam blowing through the vent pipe. The regulator valve has a composition diaphragm disc which works on expansion and when once set, seldom needs to be changed while the loop is in operation.

To start the system, open all valves into drip line and receiver, leave vent on receiver open until all air is blown out, open the starting valve until all water is drained out and steam shows, then close the starting valve and open the valves to the boilers, open the telltale valve and adjust the regulator valve until a small amount of steam shows, then open the valve to the heater, close the telltale valve and the system will be in operation.

If the flow of steam through the vent pipe should be stopped for any length of time, the system will fail to operate. This might be caused by the regulator valve not being open enough or by getting clogged up with some foreign substance, and for this reason it is advisable to have the vent pipe uncovered and pass through the engine room or boiler room or some place convenient for the engineer or fireman to feel of it once in a while and see if the pipe is hot, as this will indicate that the system is working. Should the vent pipe become shut off from any cause, the pipe will fill with condensate and become cool which will indicate that the system is not working. This is a more convenient way of keeping a check on the system than perhaps being obliged to climb to the top of a heater to test by the telltale valve.

The advantage of the steam loop is that the waters of condensation are automatically returned to the boilers while hot without the use of steam traps or pumps and with very little attention. E. C. Wells.

Increasing Size of Cylinder Liner

DUE TO OUR constitutional stupidity in not ordering properly, we received a pair of brass liners for a small water pump that was about 3/32 in. too small. It would have been embarrassing to send them back, besides we wanted to get the pump in running order without delay.

BRASS LINER WOUND WITH WIRE TO INCREASE SIZE

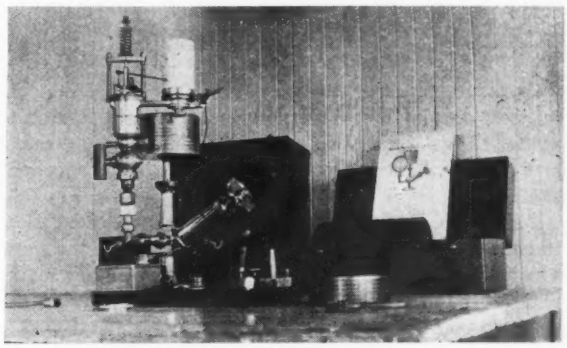
As a way out we tinned the liners on the ouside wound on bright iron wire, as illustrated and filled the space between the coils with solder, placed the liners on an arbor and filed them down to a force fit size, and placed the job in the press and forced them home and feel that we have a first class job. The error in ordering was due to the fact that the cylinders had been bored out and we had forgotten it and ordered to the original dimensions. J. O. BENEFIEL

Special Fitting for Testing Indicator Springs

IN THE Mechanical Engineering Department of the North Carolina State College of Agriculture & Engineering, we test the springs of our steam and gas engine indicator on the Crosby dead weight tester. Since all of our indicators are of the outside spring type, it is satisfactory to use the oil tester, as the springs are not under high temperature when in working condition in the laboratory or power plant.

In order to connect an indicator to the dead weight tester, it was necessary to make a special fitting as the indicators do not screw into one of the standard gage fittings which come with the dead weight tester set. To make a satisfactory fitting, we took one of the standard Crosby single indicator cocks and tapped out the lower end for standard ¼-in. Briggs pipe thread. In this way we could connect the cock to a standard ¼-in. male nipple gage fitting. We mounted the indicator on the cock and tested the indicator springs or we could test the pencil motion of the indicator for perpendicularity, etc.

The photograph shows the special fitting and an indicator in place on the dead weight tester ready for testing an 80-lb. indicator spring. This fitting has proven very useful and a considerable time saver and the method of using the dead weight tester rather than a steam drum for testing the indicator springs has proven very satisfactory. Of course this method would not do for the old style of inside spring indicators in which the springs work at high temperature, as they would have to be tested on a steam drum as usually done in the mechanical engineering laboratories.



INDICATOR CONNECTED TO DEAD WEIGHT TESTER

WM. JAY DANA.

Insufficient Power

THE WRITER was recently called upon to clear up a bit of engine trouble where the engine did not develop sufficient power for the work. The engine, a 14 by 36-in. Corliss, of a standard make, was about 30 yr. old; was second hand, or more so, and had just been erected by the purchasers. The engineer was a former garage man, and not as familiar with steam as with gas. But the engine was well enough erected. The valves were set and the engine was run a few days, but did not develop much power. Changing various rods, etc., did not help matters any, and at this point I was called in.

The throttle valve on the engine had an opening for a 4-in. steam pipe. This was bushed to 3 in. and a 3-in. line was carried all the way from the boilers. It was uncovered and had six right-angled turns. So, in the first place, the engine was supplied with insufficient steam, and that quite wet; there was no separator on the line. With the throttle valve open, and no load—friction load only—the governor was on the stop. The indicator card showed all the work being done on one end. The plates covering the valve chamber were removed and steam and exhaust valves given proper lead with the wristplate central. During this process it was discovered the valve chambers could stand reboring and new valves fitted, and also the head end valve stem had a large amount of play in the valve.

With the engine dead center the eccentric was given 1/32-in. lead. The engine was started again and card taken. The lost motion of valve stem in steam valve necessitated more changing of valve rod, but finally got the card about right.

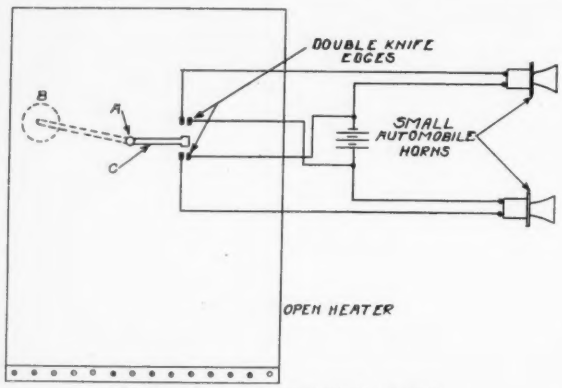
The governor rods had been changed a great deal. I lengthened the drop, or vertical rod on the governor, and then adjusted the cutoff rods, and after a few more cards obtained quite a presentable card. The load could then be carried with the governor up off the stop, and the safety cams worked when the governor was at its lowest point.

About 5 lb. back pressure was carried on the engine, the steam being used for heating. TOM JONES.

Water Level Alarm for Feed Heater

ALTHOUGH EXCEEDINGLY simple, the following description of a water level alarm may be of interest to some of the readers. I have had this device in use on an open feed water heater and it has always given excellent satisfaction.

As shown in the accompanying sketch a float B is attached to a shaft in such a manner as to cause the shaft to be rotated as the float rises or falls. The rotary movement of the shaft is transmitted to the outside of the tank to a metal arm C. The travel of this metal arm is



ELECTRICAL WATER LEVEL ALARM

limited by two sets of electrical contacts as shown. The arm short circuiting either of these two sets of contacts will sound either of the two automobile horns, which may be placed at different locations if desired.

ALONZO E. NELSON.

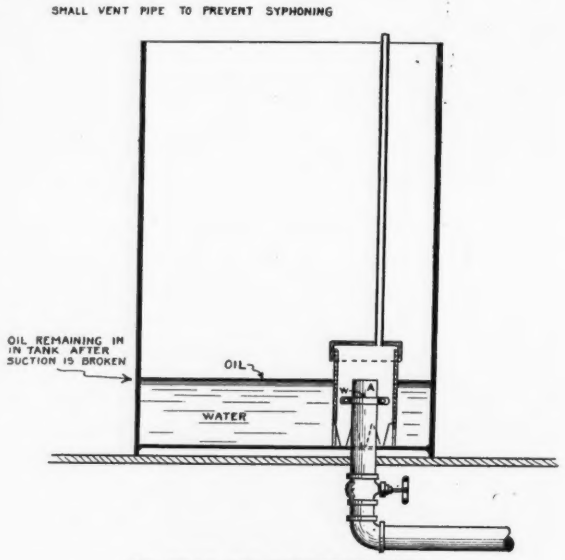
Screens for Receiving Tanks

IN THE November 15 issue, pages 1109 and 1110, under the heading of Faulty Boiler Feed Supply Piping, several arrangements for placing screens were shown and the writer wishes to suggest a simple improvement in place of those shown in Fig. 3, A and B, unless the make-up water and returns from the heating system are received for boiler feed.

The proper place to locate the screen or strainer to prevent suspended matter from being discharged into the tank, would be in the pipes to the tank.

Screens placed in the pipes to the tank will be accessible at all times and it will not be necessary to empty the tank and waste the returns which, no doubt, would be heated to some degree above the make-up water, and which would not be the case when screens are placed in the bottom of the tank.

Should oil be carried through the return pipes from the heating system and discharged into the tank the writer suggests an oil trap in the open receiving tank as shown, which will prevent the oil from flowing from the tank into the suction pipe unless the water is at its lowest level.



OIL TRAP FOR RECEIVING TANK

When closed receiving tanks are used with vent pipes to the atmosphere, the construction of the oil trap is somewhat different. F. SUTCLIFFE.

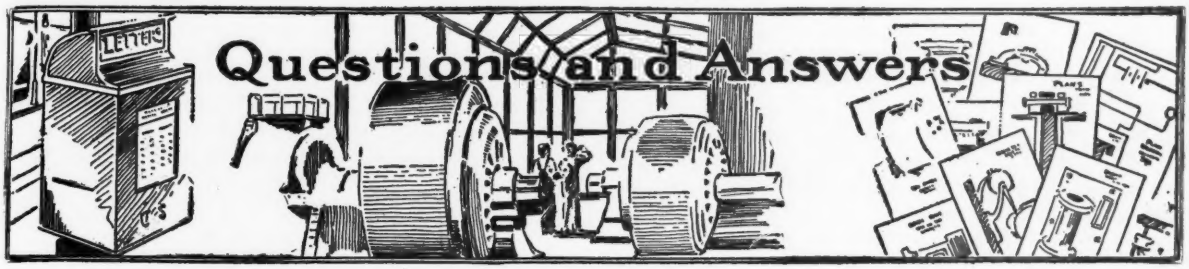
Under Grate Blower Bearings

I HAVE read A. Waldron's letter in the October 15 issue with considerable interest. Mr. Waldron would not have found, however, that the operating of this turbine blower condensing would have drawn the oil out of the bearings and destroyed them if his experiment had been made with the turbine blower, which has the bearings entirely outside of the steam-packed turbine and separated from the steam chest by regular metallic packing, deflectors, and felt packing rings in the bearing chambers. Even though the steam packing leaked and air was drawn into the steam chest, since the bearing housings are entirely in the atmosphere, no vacuum pocket can be formed, as happens in the blower to which Mr. Waldron refers.

It is pertinent to note that the writer spoke not so long ago to an engineer who had the same make of blower to which Mr. Waldron must be referring, and this engineer said he had found that oil was sucked out of the bearings with consequent bearing failure, although he did not operate condensing at all.

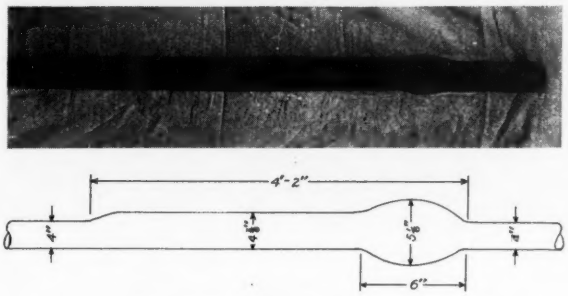
CHARLES H. SMITH.

NEARLY THREE-QUARTERS of the fatal elevator accidents that occur could be prevented if elevators and shaftway doors were equipped with well-designed interlocking devices, a survey and study conducted by the Bureau of Standards of the Department of Commerce has shown. A large number of elevator fatalities occur at the shaft door, either through an open door which allows a person to fall down the shaft or it allows a person to step from a moving car and be crushed between the car and the door frame. An inter-lock prevents the shaft door from being opened except when the car is at rest in front of the door.



What Caused the Distortion?

THE ACCOMPANYING photograph and drawing show a boiler tube which I recently removed from a 520-hp. horizontal water-tube boiler. I cannot account for the enlarged section and the bulge. The tube was not stopped up with scale or mud. The tube was not dead and no rupture occurred. Boiler inspectors and engineers that have seen the tube declare that it is a new



PHOTOGRAPH AND DRAWING OF DISTORTED TUBE

one to them. This tube was taken out of the fourth row from the bottom, in the center of the boiler. The distorted section was in the first pass. This tube had been in 8½ yr. that I know of.

I would like to have the opinion of the readers of Power Plant Engineering as to the cause of this condition. D. T. McA.

Pump Becomes Air Bound

WE HAVE a motor driven, two-stage, 4-in., rotary pump which runs at 1750 r.p.m.

This pump is 50 ft. from the bank of a creek from which the water supply is obtained, and has a lift of 13½ ft. from foot valve on suction line to the pump. The suction is 8 in. reduced to 6 in., then reduced to 4 in. at pump and has two ells between foot valve and pump. We are pumping into a reservoir which is about 1200 ft. from the pump house and is 187 ft. higher than the pump, this pipe being a 6-in. line.

The pump is rated to throw 15,000 gal. of water per hr., but it will throw only about half that amount under these conditions. It also has a habit of running fairly well for a while, then will lose its priming and quit pumping. We have also been having considerable trouble with the packing burning out on the motor end of the pump. This is supposed to be a water sealed bearing and packing should not burn out as it does. We have tried several different remedies on this pump and have failed to do it any good whatever.

I would be pleased to have your readers' views on this proposition, also information that might help me out.

The pump as it is is a great expense to us, as the cost of operation is too great for the service rendered. Any suggestions will be appreciated, and nothing spurned, even though you say throw it in the creek and get a larger pump. H. W. T.

Cause of Leaky Tubes

IN THE November 15 issue, B. C. D. describes his trouble with leaky boiler tubes.

Since these boilers were secondhand when installed, all chances are that new tubes have been rolled in and old tubes rerolled so often that the tube holes in the tubesheet are spread by the expander so that new tubes are now stretched so far out when rolled that they are weakened and are unable to hold against the sheet. Any rerolling will then make the tube thinner and still weaker.

In such a case, a ring of copper ⅛ in. wider than the thickness of the tubesheet, fitting around the tube end and inside the hole in the sheet, can be placed in the hole and rolled in lightly. When the tube is then put in place and rolled in as ordinarily done, it will surely make a tight and lasting job. E. MATZAN.

IN REFERRING to B. C. D.'s article in the November 15 issue, page 1117, I wish to state that, from the information he gives as to his trouble, I am of the opinion that if the boiler tubes first installed in these boilers were properly annealed on both ends and expanded and beaded over correctly, also that if these boilers are not working above their rated horsepower, this trouble is caused by the excessive cold air entering the furnace with the shavings which is also causing considerable more fuel to be burnt than is necessary.

I would suggest a dutch oven to be erected in front of these boilers and hoppers placed on top to which the fuel could be transferred by conveyor from a storage house. In some cases, a room built of sheet iron or a part of the boiler room is erected over the dutch ovens and the shavings fall from the conveyor into hopper on top of the dutch oven. An automatic damper in the hopper is kept closed by a weight at all times, except when a batch of shavings is either thrown in the hopper or falls into it from the conveyor; this forces the automatic damper open, allowing shavings to go through, but the damper immediately closes itself which prevents fire, sparks or smoke from coming upward through the hopper and additional cold air from entering the furnace also.

I believe that by installing the dutch oven, the efficiency of the boilers will be increased, less labor will be used to operate them, also the leaky tubes will be eliminated. H. W. ROSE.

REFERRING to B. C. D.'s conditions as explained in the Nov. 15 issue, it would appear that the trouble encountered is not traceable to the method of firing nor the boiler setting, but to some inherent defect within the boiler itself.

It is possible, of course, that the work of re-tubing the boiler has not been properly done, and it may pay him to call in some other retuber than the one who originally did the work.

Again, I would suggest the advisability of looking into the quality of the feed water, for it may contain some free acids or other impurities which have a tendency to corrode. The effects of corrosion would be more marked in a plant such as this where apparently no scale formation is encountered.

Another factor having a bearing on the matter would be the temperature at which the feed water goes to the boiler. If comparatively cold water is fed to the boilers, expansion and contraction strains might be set up which could account for some measure of this trouble.

Still another point to be investigated is the manner in which the feed water is admitted to the boiler. Perhaps the discharge of the feed water is such that additional strains are set up. If it is not being done it would pay to use brass pipe and carry the feed pipe back through the boiler about 3 in. above the tubes a distance about 20 in. from the rear head, whence it is carried across to the opposite side and discharged down between the tubes and the shell.

Or the tube sheets of these secondhand boilers might be in such poor condition that no kind of re-rolling or re-tubing would hold. With the record of repairs which these used boilers have shown, it should certainly pay to have a thorough examination made of them by an expert boiler maker, for if they are inherently bad in design, construction or present construction, it would be much cheaper to pay the price for new equipment rather than to endeavor to repair or attempt to repair the present boilers.

The 18-ft. boilers which gave no trouble may have been of better design and construction than those now used, and this probably was the case, for it seems unreasonable to credit all the difficulty to such a slight change in dimensions alone.

M. A. SALLER.

Operation of Centrifugal Pump

REFERRING TO the question under the above caption submitted by J. C. L. on page 971 of the October 1 issue of Power Plant Engineering, I would say that the power required to operate a centrifugal pump depends on the amount of water that is being discharged by the pump.

If the discharge valve were closed, or the suction line shut off from any cause, no water would be discharged and the power would be decreased.

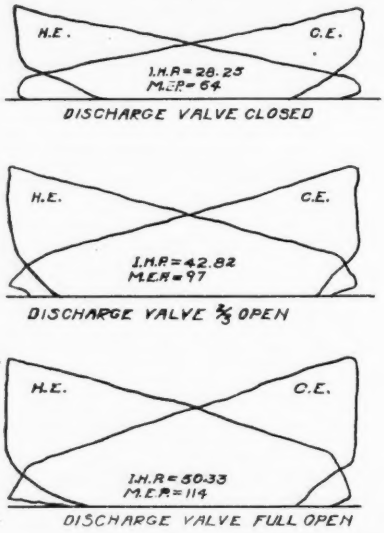
No injury would be caused to the installation if the discharge valve remains closed until the pump is up to speed, but if it remained closed for a great length of time, the pump would become heated due to friction caused by the impellers or blades revolving through the water held in the pump casing. This heat would cause a vapor to be formed which would destroy the vacuum and prevent the pump from taking water, especially on a high lift.

Some time ago I was employed in a plant where several centrifugal pumps were used for different purposes and this same question was brought up.

One installation consisted of two centrifugal pumps, one motor driven, and the other engine driven, with throttling governor. Both pumps were connected to a common pipe line which supplied injection water to a barometric condenser.

For the benefit of those discussing the question of the power required to operate the pump with the discharge valve closed, indicator cards were taken from the engine with the discharge valve closed, partly open, and full open. I submit a reproduction of the cards taken which shows the results obtained.

Another installation in this plant consisted of two motor driven centrifugal pumps which pumped water from a river to a tank located below the engine room floor. This water was also used for condensing purposes, and as the pumps were located on the river bank, some distance from the engine room, the ammeter gages, which were located in the engine room, were used as a check on the operation of the pumps. If the current fell below normal on either pump, it was an indication that



INDICATOR DIAGRAM FROM ENGINE DRIVING A CENTRIFUGAL PUMP WITH DISCHARGE VALVE CLOSED, TWO-THIRDS OPEN, AND FULL OPEN

that pump was not doing its full duty. This was frequently caused by the pump getting air bound due to leakage in the packing on the impeller shaft. Vent pipes were connected to the top of the pump casing and by opening the valves on these pipes the air was expelled.

Whether the valve on the discharge from a centrifugal pump should be opened before the pump is started or not depends on conditions.

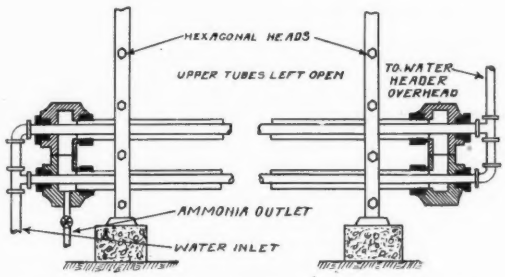
In the case previously mentioned, where the two pumps were discharging into one line for injecting water, I would say that when the load was light and injection water cold one pump was sufficient to furnish the water required; but as the load increased, both pumps were required and in this case the pump was brought up to speed before the discharge valve was opened.

This was done to guard against the possibility of leaky check valves which would allow part of the water which was being discharged from the pump in operation to pass through the pump that was idle, and also to prevent the possibility of air being drawn into the condenser through the empty pipe lines, either of which would impair the vacuum or cause its loss entirely.

E. C. WELLS.

Change in Condenser Design

REFERRING TO G. G.'s condenser problem in the November 1 issue: A double pipe condenser is sometimes used during the cold winter months with no water passing through it. In this case, all the water return bends are removed and the inner tubes are left open so that the cold air may circulate through. The cooling effect is often enough to condense all the ammonia circulated for the light winter load. If more condenser effect is wanted, water may be turned over the coils so as to make a regular atmospheric type apparatus.



SUGGESTED AMMONIA CONDENSER CONNECTIONS

My solution of the problem would be to remove all except the lowest return bends and therefore have the tubes open to the air. The lower two tubes would be left as they are with the exception that the outlet header would be connected directly to these two tubes, as shown in the accompanying sketch, instead of to the top of the bank.

This furnishes a good opportunity to clean the water tubes. They should be drilled and then brushed out with a graphite oil to prevent rusting. E. MATZAN.

Crank Case Leak

IN REFERENCE to L. C.'s article appearing in the Oct. 15 issue, page 1022, I have observed with interest, and in reference to the matter, it would be an easy mechanical job to correct this defect of this porous crank case if the time was available to do it properly.

I would suggest first to remove the crank shaft and all working parts of the engine which operated in the crank case, and next drain the crank case of all its oil, after which I would proceed to wipe it out with the dry cloth or waste. Then take a blow torch and run over the sides and bottom of the crank case, using it in the same manner as if you were burning paint off a wall as a painter does when preparing surfaces for new paint. This procedure of heating with blow torch is for the purpose of thoroughly drying out and opening up the pores of the metal which may be clogged with oil.

After this part of the work is accomplished, the next step would be to make up a solution of some chemical liquid which would fill the crank case the same as the oil does, this liquid to be allowed to remain in the crank case long enough to penetrate the leaky pores, which would necessitate several hours, after which the liquid could be drained from the crank case through the drain plug. Then go over the inside bottom and sides of the crank case with a painter's brush, and allow them to dry thoroughly, after which the engine could be put together ready for service. One chemical for this piece of work which could be secured from one of the many paint factories which manufacture it would be a barrel of what is known as fireproof enamel roof paint. Place this in the crank case, allowing it to remain the above-mentioned time, then the paint could be drawn off and used for its original purpose. The idea of filling the crank case full of the liquid is for the purpose of placing a pressure on the inside so as to force the liquid into the pores of the metal.

Should time not permit this process of repairs, after employing the method described up to the time of filling the case with liquid, have the case thoroughly heated to an ordinary flesh bearing temperature and then use one of our many cements and thoroughly work it into the pores with a paint brush, applying a reasonable coat all over, using an iron cement for eliminating cracks and pores in all parts of the engine. I am sure that this will prove also to be a satisfactory repair job at quite a small cost. H. W. ROSE.

Longest High Tension Span

IN THE November 1 issue of Power Plant Engineering, S. R. Blakeman states that he thinks a span of 4427 ft. is the longest high tension transmission span in the United States.

Across a gorge on the Little Tennessee River in western Tennessee there is a span 5010 ft. long which is generally supposed to be the longest conductor span in the world.

There is a 150,000-v., three-phase transmission line. Each cable consists of 22 strands of 0.150-in. aluminum wire having a total section of 500,000 c.m. The aluminum is wound around 61 strands of 0.097-in. high grade steel. The core diameter is 0.873 in. and the overall 1.175 in. DEAN REYNOLDS.

U. S. CIVIL SERVICE COMMISSION announces examinations as follows, to fill vacancies in the Bureau of Standards, Department of Commerce, Washington, D. C., at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries: Physicist, $2800 to $4000 a year; Associate Physicist, $2000 to $2800 a year; and Assistant Physicist, $1500 to $1800 a year. Applications will be rated as received until further notice. Appointees at annual compensation of $2500 or less, whose services are satisfactory, may be allowed the increase granted by Congress of $20 a month. Applicants must not have reached their fifty-fifth birthday on the date of making oath to the application. This does not apply to persons entitled to preference because of military or naval service. Apply for Form 2118, stating examination title.

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Centralized Boiler Control

As one watches the trend of practice in modern large power plants, there is noted a growing tendency toward centralizing the responsibility for boiler room operation all upon one man. The days when the work of one boiler attendant was compared with that of his fellow worker on the next boiler are fast going back into history.

While the efficient and safe operation of the most modern boiler room is still dependent upon watchfulness and knowledge of the boiler attendants, great strides have been made towards automatically maintaining correct conditions of feed water temperature, steam pressure, water level, fuel feed and air supply, and instruments have been so perfected that it is no longer necessary for the boiler room foreman to be actually in the firing aisle to know just what the operating conditions of the steam generators may be. So we find in the South Meadow Station, a description of which appears in this issue, a room in which are located a full set of indicating and recording instruments for each and all boilers under the observation of the man in charge.

Unquestionably this practice will grow gradually to include the operation of more and more of the principal valves of the plant by motors with controlling switches in the centralized control room, as has been the case in the turbine room where even the speed of the turbine while being synchronized is controlled by the switchboard attendant.

Another tendency of practice which contributes to the growth of centralized control is the increasing use of motor-driven auxiliaries, particularly pumps of the centrifugal type. It requires no stretch of imagination to conceive a power plant whose principal equipment is controlled entirely from one central point. Such a plant would required technical knowledge of a limited number of men in charge of the different departments while the operatives' duties would consist principally in keeping the mechanics of the plant in fit shape.

While the tendencies toward centralized control are more common in the large central stations they are just as applicable in the smaller plants where automatic control of stokers and air supply is practicable. Even now the chief engineer's office in modern plants contains the principal indicating and recording instruments of the plant and it is only a short step in advance to add to this equipment means for controlling the variable conditions of the principal machinery of the plant.

By thus concentrating the responsibility for the operation of the plant in the hands of a few men, better results should be obtained and the plant would not require so many highly trained men as it does under methods most commonly used today.

Guarding Against Failure

With the rapidly increasing use of long transmission lines and the advent of large interconnected systems in electric power distribution, the problem of maintenance and of forestalling trouble grows in importance. In case of failure on such systems the loss due to cost of repairing damaged apparatus is often insignificant as compared to the loss incurred by spoiled manufac-

tured products occasioned by the interruption of the power supply. This fact cannot be impressed too strongly upon the minds of those responsible for the protection of the systems against failure.

When contemplating the installation of protective equipment, the savings incurred throughout the future life of such equipment should always be carefully weighed against any first cost considerations. The savings resulting from the effective functioning of correct protective apparatus in a single case of damaging disturbance will often offset its original cost many times over.

In order, however, to determine the proper methods of protection for any particular system, it is essential to know something in regard to the nature of the disturbances which are responsible for accidental shut downs. Failures on large systems or long transmission lines are due not only to external disturbances such as may be caused by direct or induced lightning discharges, but also to destructive internal disturbances caused by short circuits, arcing grounds, sudden breaks, etc. Not only, therefore, must we protect the system against the disastrous consequences of destructive disturbances, but we must extend our efforts as much as possible in an endeavor to prevent their occurrence, or, if they do occur, to confine them to a limited portion of the system. On underground cable systems for instance the occurrence of a ground is a frequent and serious cause of high potential disturbance. Such grounds cause oscillatory phenomena which often breaks down the insulation at remote points on the lines. These grounds soon develop into short circuits. It is obvious, therefore, that the sooner the section of the line on which the ground occurs can be discontinued from the system as a whole, the less will be the danger of damage to the connected equipment. By properly grounding the neutral on such systems and by the installation of suitable protective relays, any grounded section will be instantly and automatically disconnected. The cost of the relay equipment will be negligible in comparison to what might have to be expended in repairing a machine which was damaged under the conditions described above.

The grounding of the neutral and the installation of relays, however, represents only one of the numerous methods and devices available for securing protection. We are more or less familiar with the common methods of protection; others we recognize only by name. Why do we install certain protective apparatus? To secure protection against certain disturbing conditions, to be sure, but the question now arises what are these disturbing conditions?

In the pages of this issue will be found the first of two articles by H. W. Smith in which he discusses some of the transient phenomena in alternating current transmission lines and methods of protecting against abnormal disturbances. Mr. Smith not only discusses the possible disturbances but also the magnitude of the stresses to which apparatus connected to large systems may be subjected. The electromagnetic stresses which may be imposed upon a generator or transformer due to short circuit or out of phase conditions, it must be remembered, are proportioned to the square of the current. Under short circuit conditions, therefore, the forces acting to destroy the machine may often be several hundred times the normal stresses due to full load current. Modern equipment can be designed to limit the short circuit current to a reasonably safe value, but in the case of old equipment not designed to resist such tremendous stresses, suitable reactors or other protective apparatus must be provided to guard against its destruction.

The problem of maintaining continuity of service on large systems is a difficult one, the solution of which requires a thorough knowledge of all possible disturbing conditions and of the methods available to prevent them. Each system presents problems requiring individual attention, but with a thorough knowledge of fundamentals each case may be attacked with greater confidence of arriving at a correct solution. Mr. Smith has handled the subject in a practical manner and it is hoped will give the reader a better insight into this phase of electrical engineering.

Power Plant Slogans

Keep and Analyze Operating Records in Every Power Plant.
Develop Water Power Sites.
Promote Health and Safety in Power Plants.
Handle Coal and Ashes Mechanically.
Employ Engineers for Engineering Work.

The Fun of Business

By Dr. Frank Crane

THE HAPPIEST man in the world is the one who is doing what he's always wanted to do and making it pay.

There are all sorts of reasons for carrying on a business, but the best reason is, because you like it.

Fun is a good deal a matter of habit, and of point of view.

It is as interesting to make tack hammers and sell overalls as it is to play pinochle or polo, if you look at it that way.

A child is happy when he stretches his legs, expands his lungs and sharpens his wits playing hide and seek. And a man is happy when he plays the great game of making and selling, because it interests him, while hide and seek does not.

Every job is an adventure. Men are always standing in the doubtful ridges of the battle. Every day they must use their judgment, shoulder responsibility, make decisions, estimate men and try to see into the future.

And, take it by and large, it's a fair game, and, played honestly, both sides stand to win.

The business man is the servant of the people. He is not merely feathering his own nest, but he is doing something for the people that they want done. And the man who best serves is the man who has the best excuse for living.

If there is going to be any jury on the Day of Judgment, I hope it will be made up of men who worked hard all their lives. Such a jury would come nearer handing out even justice than any other sort of jury.

Copyright, 1921, by Dr. Frank Crane.

Conical Mill for Pulverized Fuel

IN A BULLETIN entitled "Pulverized Fuels," the Hardinge Company describes the application of its conical mill for pulverizing fuels. Although the adoption of this mill for pulverized fuel service is comparatively recent, it has been fully demonstrated as being satisfactory and reliable.

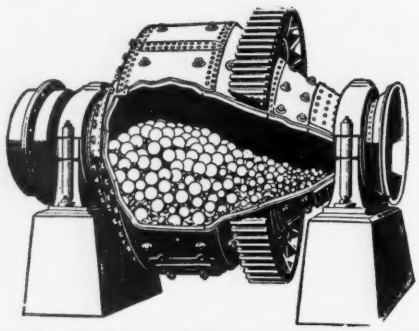


FIG. 1. CONICAL MILL SHOWING CLASSIFYING ACTION OF CONE

The Hardinge mill, shown in Fig. 1, operates on the principle of a multiplicity of grinding bodies rolling in a rotating conical drum supported on hollow trunnions, through which the material passes into and out of the grinding zone. The grinding bodies, in rolling and dropping, grind and crush the material passing through the mill.

Due to the conical shape, a condition exists in the mill which causes a natural segregation of both the grinding media and the material being ground. The coarse material, on entering the mill through the hollow feed trunnion, is crushed by the large balls (or pebbles) which always remain near the feed end (largest diameter), due to the classifying action of the cone. As the particles are broken down, they automatically work their way forward, being subjected to a gradually diminishing breaking and crushing effect as they decrease in size. The particles undergoing reduction reach the required degree of fineness and the discharge opening at the same time. This automatic classification of both the materials being reduced and the grinding media, proportions the energy expended to the work required; in other words, the fundamental principle of grinding is being obeyed. This classification of material undergoing reduction, as well as of the grinding bodies, is illustrated in Fig. 1. This shows that in the largest diameter of the mill the incoming feed is crushed by the largest balls or pebbles, as the case may be, with the greatest superincumbent weight, with the greatest height of fall and the highest peripheral speed. As the discharge opening is approached, the crushing force is gradually diminished, since the grinding media are smaller and are dropped from a lesser height. The material undergoing reduction travels towards the discharge end as fast as it is reduced, thus allowing the full force of the heavy blows to fall upon the coarser particles behind without being partially absorbed by fine material as is the case when automatic segregation does not occur.

In Fig. 2 is illustrated a typical powdered fuel plant incorporating the conical mill described above. From cars, the coal is dumped into a track hopper, and fed directly to a crusher to reduce it to 1-in., or smaller, and then elevated by a bucket elevator to a dryer storage bin. From the dryer storage bin the coal is fed to the dryer and dried to a moisture content of approxi-

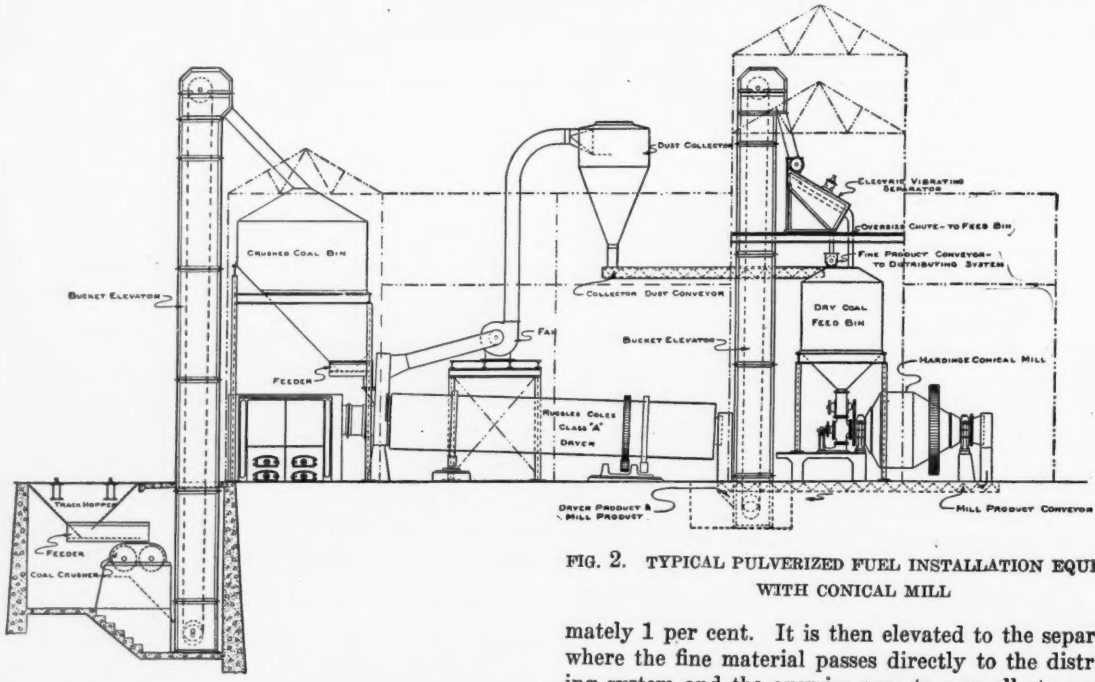


FIG. 2. TYPICAL PULVERIZED FUEL INSTALLATION EQUIPPED WITH CONICAL MILL

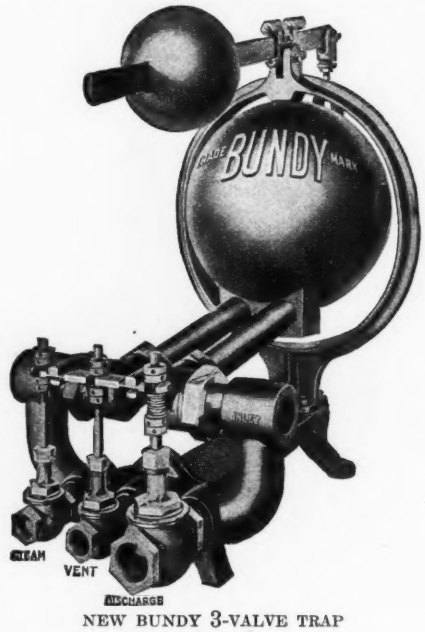
mately 1 per cent. It is then elevated to the separator, where the fine material passes directly to the distributing system and the oversize goes to a small storage bin ready for feeding to the conical mill.

From the feed bin the coal passes through the mill, is pulverized and discharged to conveying equipment for returning to the separator. This separator is either an electrically vibrated screen of novel construction, or an air separator. From the separator, the oversize is returned to the feed bin of the mill for regrinding, while the finished product is conveyed to storage.

A Three-Valve Pumping Trap

SEVERAL innovations are found in this new Bundy trap which make for smooth and effective working. The principle of operation is the same as in older designs, so that the middle or vent valve is open while the trap is in the upper (filling) position, the steam and discharge valves being closed; at the lower (discharge) position, the vent valve is closed and the others open.

Changes are in bearings and connections. The weight lever travels on ball bearings and strikes against a cushion which prevents shocks; valve stems are attached by non-rigid connections which avoid rigidity and permit easy removal for renewal or repair without disturbing other parts of the trap; large valves admit rapid filling and emptying and free vent. The combination of these features gives a trap especially adapted for use where condensation from low-pressure or vacuum systems is to be handled, and provides a maximum of capacity. The new trap is made with connections from ¾ in. to 3 in. and capacities of 1500 up to 16,000 lb. per hr., by the Nashua Machine Co., Inc., of Nashua, N. H.



NEW BUNDY 3-VALVE TRAP

New Turbine Instruments

THE SAFE and successful operation of steam turbine generator sets has been aided through the recent development by the General Electric Co., of a turbine trip switch which provides an automatic means of signalling the operator at the switchboard when the throttle valve is tripped, by over-speed, vibration, or other emergency. In some cases, considerable damage has occured due to turbines being allowed to motor with consequent overheating, after the steam was shut off.

The switch is actuated by the last ¼ in. motion of the throttle valve stem, and may be so arranged as automatically to set off an audible, or other form, of alarm signal at the board, or, if connected to the main generator switch, to disconnect the turbine automatically from the line.

The second device, a vibration indicator, was developed to measure quantitatively the motion or vibration of any external portion of the turbine generator set, either transverse, or longitudinal. The scale is calibrated in thousandths of an inch.

FIG. 1. TRIP SWITCH (CASING REMOVED) OPERATED BY THROTTLE VALVE OF TURBINE

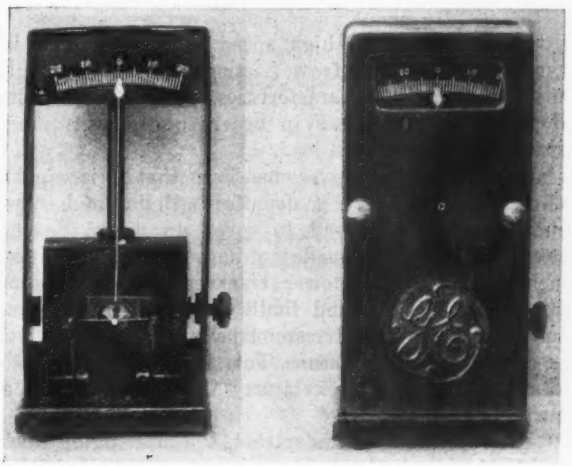


FIG. 2. VIBRATION AMPLITUDE INDICATOR

The indicator consists of a cage supporting a relatively heavy weight as a pendulum. When the cage is placed on the part to be tested, the motion of the part

is transmitted to the cage, the weight remaining stationary. The relative motion between the cage and the weight actuates a pointer which measures the amount of the motion definitely and accurately. The ability to determine definitely the effect of any change in the balance weights, or other conditions is a great improvement over the former methods, which depend entirely on individual memory and judgment.

Rocking Cableway Coal Handling Apparatus

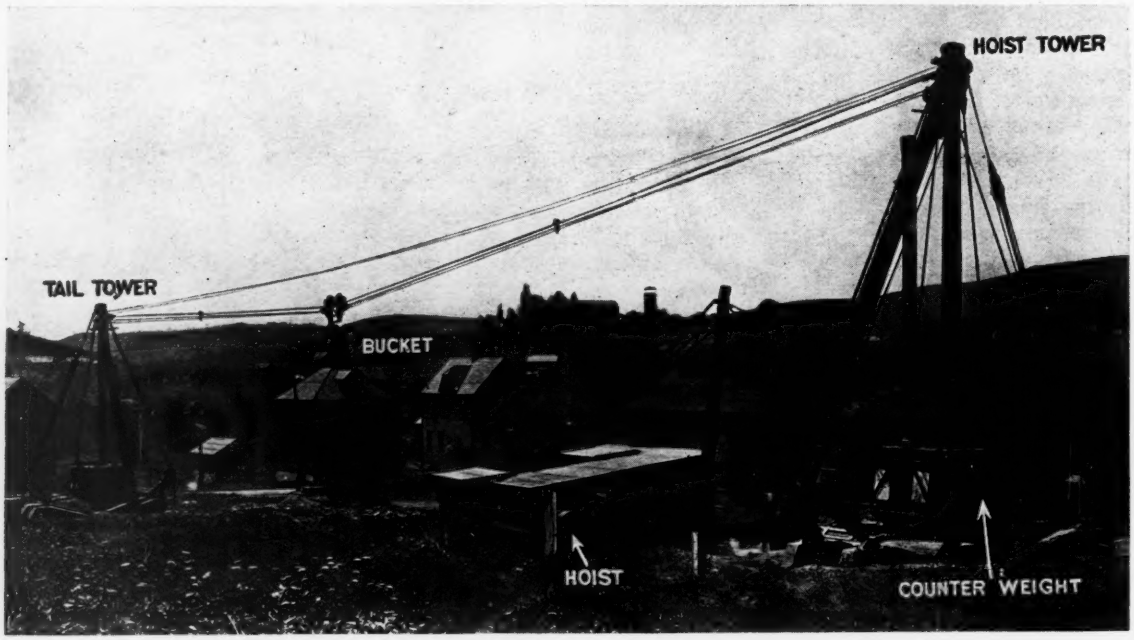
THE MERITS of a cableway as a hoisting and conveying device have long been recognized. It is about the only device that can be used for operating over a long span, regardless of the contour of the ground beneath. Its high speed possibilities and its comparative freedom from friction losses are strongly in its favor and its characteristics obviate the necessity of moving large masses in order to convey a much smaller and lighter live load.

Its limitation, however, has been that it is capable of operating only over a definite fixed line and consequently cannot be used to cover an area. Several attempts have been made to improve this condition, such as moving the tower transversely on rails, but this is cumbersome, and limits the practical size and height of the tower. It cannot be operated in this way as a load conveying means, but simply functions as a means for moving the cableway from time to time as purposes require.

A new system on the market, the Harrington Rocking Cableway, is designed to overcome this limitation. The device has been made possible by the use of counterweights, on the head and tail towers by means of which the entire system is balanced so that the tower or towers can be rocked transversely to the line of cable with a minimum amount of power and speeds commensurate with the speed of travel of the carriage along the cable. This addition of the rocking feature is the only radical deviation from standard cableway practice.

By this means, then, a cableway can be built to serve an area whose width is roughly 1½ times greater than the height of the tower itself.

The design is such that the bucket, skip, or packet can load to and from cars on tracks or to the coal handling system of the plant. By combining the movement of the cableway as a whole, with that of the bucket itself on the cable, a resultant travel at any angle across the pile may be obtained by the operator who can be located at the hoist, in a tower above the hoist, or, if necessary, at any other convenient location where he can have full view of his equipment.



ARRANGEMENT OF COUNTERWEIGHTED MASTS OF THE ROCKING CABLEWAY COAL HANDLING SYSTEM

Fall carriers are essential in preventing the sag in the operating ropes from interfering with the successful operation of the bucket. This carrier is designed on a differential principle which automatically spaces the carriers without coming in contact with the carriage. The carriage is the standard type, and is arranged so as to handle satisfactorily the operation of any type of bucket, skip or packet.

There is a counterweight mounted on each tower, not rigidly connected to the tower, but supported by suspension cables and held in position by lashing cables as shown in the accompanying illustration. The counterweight is sufficiently heavy to counterbalance the towers, together with all cable and tackle, the carriage and bucket or skip, and when desirable may be made to balance the live load.

The rocking mechanism consists merely of the cables and the necessary tackle. These cables, after leaving the rocking hoist drum are carried up the tower, down over the multiplying blocks, up to the top of the head tower and across to the tail tower where they are reeved

through multiplying blocks similarly placed to those on the head tower. A simple reeving causes the towers to rock in unison.

The arrangement of drums is modified to meet the individual conditions of each particular cableway. They can be arranged for electric, steam or gasoline engine drive.

Such a cableway system has recently been installed at the plant of the Railway and Industrial Engineering Co. at Greensburg, Pa. It is operated by an electrically driven, four-drum, internal friction, single motor type hoist. The motor is constant speed, non-reversible and operates on a 440-v., 60-cycle current. The drums are reversed through reversing clutches. The head and tail towers are set at different levels, due to 12 ft. difference in elevation, they have an angular movement of 90 deg. and as they are about 35 ft. high, the lateral movement is about 50 ft. As the span is 220 ft. the space covered is 9460 sq. ft., leaving about 15 clear at each end of the space, which means, assuming the angle of repose of the coal stored as 40 deg., that a height of 21 ft. at the ridge is obtainable, and that consequently about 91,000 cu. ft. or about 2600 T. can be stored.

The average time for a complete cycle of operation, consisting of loading, hoisting and moving the bucket diagonally across the entire area, unloading and returning to the starting point is about 50 sec. The speed along the cable is given as 800 ft. per min., the hoisting speed 120 and the transverse movement of the cableway, 250. Approximately 975 cu. ft. or 23 T. may be handled per hour with a ½-cu. yd. bucket.

Small Motor Starter with Safety Features

A NEW TYPE of motor starter which provides complete protection both to the operator and the motor, has been developed by the Westinghouse Electric & Manufacturing Co. for starting small alternating current motors by connecting them directly to the line.

COMPACT AND RUGGED MOTOR STARTER

This starter consists essentially of an enclosed quick-make-and-break knife switch, which is operated by an exterior handle. It protects the motor from overloads both when starting and when running because it is equipped with thermal cut-outs which open the circuit on dangerous sustained over-loads, but do not operate under harmless momentary over-loads. The cut-outs resemble cartridge fuses, but are not interchangeable with fuses so that the latter cannot be substituted for them. They operate by fusing a special washer, which can be replaced in a few seconds' time at negligible cost.

All parts are enclosed so that the operator cannot touch live contacts. A door gives access to the cut-outs, but this door is interlocked with the switch and cannot be opened unless the switch is in the off position, when all accessible current carrying parts are dead. If desired, this door can be padlocked to prevent access of unauthorized persons to the cut-outs. It is also possible to lock the handle in the off position with three separate padlocks for the protection of those working on the machinery controlled by the switch.

These starters are made in sizes for alternating current motors up to 3 hp. 110 v.; 10 hp., 250 v.; and 10 hp., 600 v.

News Notes

JULIAN D'ESTE CO., of Boston, on Jan. 1 will remove its Chicago office from N. Market St. to 318 W. Washington St.

A. H. SLOAN & CO., INC., of Detroit, Mich., have been appointed as representatives of the McClave-Brooks Co., of Scranton, Pa.

THE HOWARD IRON WORKS and Alberger Heater Co. now have offices at 728 Monadnock Building, Chicago, Ill., which are in charge of G. W. Heald and A. J. Saxe.

COMBUSTION ENGINEERING CORPORATION announces the recent opening of two branch offices, one at 216 Latta Arcade, Charlotte, N. C., in charge of T. E. Nott, and the other at Seattle, Wash., where Fryer-Barker Co., 1133 Henry Building, is the representative.

THE BETSON PLASTIC FIRE BRICK CO., of Rome, N. Y., announces that its Chicago office will be in charge of C. Z. Dillenbeck, Kimball Building, Chicago, Ill., and L. S. Shaw & Co., main office 5716 Euclid Ave., Cleveland, Ohio, will act as general agent and distributor for the states of Michigan, Ohio, Indiana and Kentucky.

B. A. LEWIS has resigned his position as advertising and sales manager, merchandise division of the American District Steam Co., North Tonawanda, N. Y., with which he has been associated for the past 19 yr., and will on Jan. 1, 1922, open a sales office in Buffalo, specializing on heating equipment, including products of the American District Steam Co.

H. C. SOULE, who for some time past has been manager of the apparatus department of the Westinghouse Electric International Co., with headquarters at East Pittsburgh, sailed from New York, Nov. 19, for Buenos Aires, Argentina, where he will take up duties in the office of L. T. Peck, managing director of the Cia. Westinghouse Electric Internacional, S. A., of Argentina.

Mr. Soule has been associated with the Westinghouse Co. since 1903. After graduating as an electrical engineer from Syracuse University he entered the ap-

prentice course at East Pittsburgh, which he finished in 1905, and was detailed as design engineer on power transformers. He progressed until in 1913 he was appointed general engineer on transformers and central station work. In March, 1919, he transferred to the Westinghouse Electric International Co., taking charge of the negotiation section and after a year on this work was made manager of the apparatus section.

WHITING CORPORATION, Harvey, Ill., has purchased a controlling interest in the Grindle Fuel Equipment Co., manufacturer of complete powdered coal plants. The Grindle Fuel Equipment Co. has moved its offices to Harvey, Ill., and will continue its business under the same name; Whiting Corporation will manufacture all Grindle equipment.

THE JOS. W. HAYS CORPORATION, of Michigan City, Ind., has announced the appointment of the J. W. Murphy Co., 108 S. La Salle St., Chicago, as exclusive representative for northern Illinois and the mill district of Indiana. All matters pertaining to Hays instruments should be taken up with the new representative, both as to purchase of instruments, repairs, and questions in regard to use.

R. L. WARBURTON, for a number of years connected with the Celite Products Co., has become identified with the Quigley Furnace Specialties Co., in the capacity of sales engineer. Mr. Warburton's general knowledge of furnace design and operation coupled with his experience in the application of insulation for furnace structures and other purposes, enables him to offer constructive ideas to furnace users and others interested in heat insulation.

U. S. CIVIL SERVICE COMMISSION states that the Bureau of Standards at Washington, D. C., is in need of junior aids and laboratory apprentices, and that it will receive applications for those positions until further notice. The basic pay offered is $540 a year for apprentices and $720 to $840 a year for aids, to which salaries there is added the increase of $20 a month granted by Congress. The Bureau of Standards covers a wide field of work in physics, chemistry, engineering, and industrial technology, and offers valuable experience to those preparing for those professions. Junior assistants at the Bureau of Standards are given opportunity to continue their college work at the universities in Washington, the courses of which are largely arranged to suit the convenience of persons in the Government service. Applicants are not required to undergo a written examination but are rated upon the subjects of general education and experience, weighted at 30 per cent, and professional training and experience, weighted at 70 per cent. Full information and application blanks may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or with the secretary of the local board of civil service examiners at the post office or customhouse in any city.

U. S. CIVIL SERVICE COMMISSION states that there is a shortage of eligibles for positions of hydrographic and topographic draftsmen in the Coast and Geodetic Survey for duty in Washington, D. C., and at the field station at Manila, P. I., and that it will receive applications for such positions until further notice. Entrance salaries range from $1600 to $2000 a year, to which there is added the "bonus" of $20 a month granted by Congress. Applicants are not required to undergo a written examination, but are rated upon the subjects of education, training and experience, and drawing and lettering. Full information and application blanks may be obtained by communicating with the U. S. Civil Service Commission, Washington, D. C.

Books and Catalogs

THE ENGINEERING Advertisers' Association of Chicago is now publishing a monthly bulletin in the interest of its members, giving a digest of the speeches made at the various meetings and also including other information and facts regarding the movement of goods from industry to industry, personal notes and trade news. The current copy includes an address by Kenneth Groesbeck, vice-president of the Harry Porter Co. of New York City, on the Baconian Theory of Advertising, which is well worth reading.

We are advised that at the present time there are a limited number of extra copies of the Bulletin which will be sent upon request to the advertising managers of concerns selling technical or engineering products.

A NEW CATALOG, 108-C, on centrifugal pumps, has just been issued by the Wheeler Condenser & Engineering Co., Carteret, N. J. It describes construction details and fully illustrates the application of high efficiency double suction pumps for every purpose. Single stage horizontal and vertical shaft pumps and multirotor pumps are included. Of special interest are the illustrations of circulating pumps for condensers of all sizes. Several types are also shown for each of the other usual pumping services, many of which are of special and unusual design. The meaning and application of centrifugal pump characteristics are thoroughly explained. Methods are given for constructing the characteristic curves of a centrifugal pump at varying speeds where the characteristics are known for constant speed operation. Instructions are given for installing and operating centrifugal pumps and also much useful data for making calculations and writing specifications.

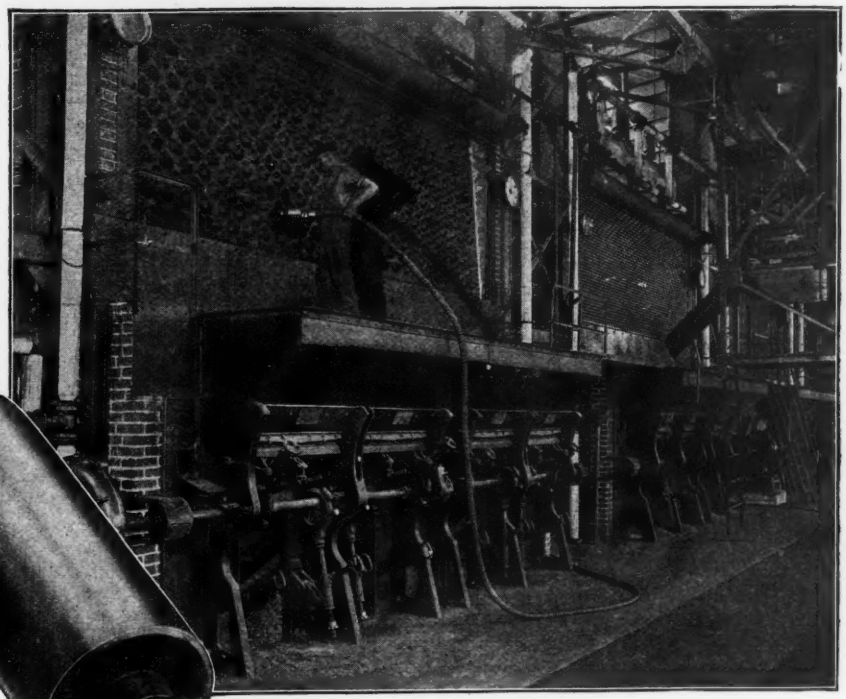
CHICAGO PNEUMATIC dry vacuum pumps, steam, belt and motor driven, are described and illustrated in a 28-page bulletin, No. 710, lately issued by Chicago Pneumatic Tool Co., New York.

A folder—Special Publication No. 674—from the same company lists some Chicago Pneumatic products, among which are hammers, riveters, drills, geared hoists, winches, motors and compressors.

A NEW Pratt & Cady Catalog, No. 6, of attractive appearance and containing additional lines not shown in previous catalogs, illustrates brass and iron body valves and asbestos packed cocks. Among products not previously catalogued are 800-lb. iron valves, four varieties of union bonnet valves, and Pratt & Cady automatic stop and check valves.

A LEAFLET discussing nozzles, their relative efficiency when used in connection with mechanical soot blowers, and illustrating the Bayer gun barrel type of nozzle, showing by illustration a practical test determining the comparative projecting power of that type, was recently received.

LIBERTY



Liberty Cleaner at work in the fine new power plant of the Hershey Chocolate Co., Hershey, Pa.

Liberty Cleaners are made for cleaning all sizes of boiler tubes, straight or curved, in fire or water tube boilers.

Essential Equipment

The best of power plants is not complete without Liberty Tube Cleaning Equipment for keeping the boiler tubes clean and in such shape that the heat transfer through the tubes compares favorably with all other phases in the process of making power.

Regular use of Liberty Cleaners insures clean tubes. Maintenance of Liberty Cleaners is extremely low.

Write for Catalog Z

LIBERTY MANUFACTURING CO., 443 Grant St., Pittsburgh, Pa.

Z-927

CLEANERS

If you are having trouble with Flax Packing

try

SQUARE
PALCO
PLAITED PACKING

For Hydraulic and Low Steam Pressures

"PALCO" is made of a fine grade of high tensile strength cotton, lubricated with graphite grease in each separate strand.

Superior in every way to pre-war flax packings.

Price moderate.

Ask your dealer for "PALCO".

Let us send you a free working sample to test.

GREENE, TWEED & CO.
Sole Manufacturers
109 Duane St. New York

NEW YORK BELTING & PACKING COMPANY

Standardize on these Packings

From our line of tested packings you can select a type to meet every power plant need, whether for steam, air, water, ammonia, gas, oil or chemicals.

These highly specialized packings are the result of a careful study of the packing requirements on modern power plant machinery, and their proved efficiency is the outcome of exhaustive tests and observation of each packing under actual service conditions.

You can STANDARDIZE on these packings with the certainty that each item is right for the service intended. A few of the leading styles are shown herewith:

Indestructible White Sheet Packing—Style 10. A high grade rubber packing for general use: air, water, gas, creosote, ammonia and steam to 150 pounds pressure. Carried in stock in rolls 36" wide, 1/32", 1/16", 3/32", ⅛", 3/16", ¼" thick.

Cobbs Piston Packing—Style 2. For steam to 150 pounds pressure, air and gas.

Firo Superheat Sheet Packing—Style 1846. For superheat steam, acids, ammonia, alkali and all cases requiring a heat-proof, non-absorbent, firm sheet packing. Made from long fibre asbestos, with suitable binder, compressed into sheets under tons of hydraulic pressure. Carried in stock in sheets 40"x40", 1/32", 1/16" and ⅛" thick.

Turxo Valve Stem Packing—Furnished braided or twisted, on spools of one, two or five pounds each.

Make use of our consulting service by submitting your packing problems for advice and solution

NEW YORK BELTING & PACKING CO.

Rubber Goods for Mechanical Purposes

New York	Pittsburgh
Boston	St. Louis
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Convenience

much appreciated by many users

AMBEST Flexible Metallic Packing

Encased in close braiding of strong cotton thread. All sizes in spiral, and in rings to measurements.

The **"Last Thing"** in **Flexible Metallic Packing**, and worth looking into.

May we send a sample ring?

Loose strands in 5, 10 and 25 lb. sealed cans. Easily twisted to any size needed

Eureka Packing Co.

79-81 Murray Street **New York**

Funny—But—

this is a case where the hole is worth money.

Belmont Hollow Center Packing Style No. 19

Cross sectional view showing the round hole.

is built along absolutely scientific lines to insure tightness without undue friction.

It's this way—the hole offsets the expansion and contraction due to change in temperature. This automatically maintains just enough tightness to prevent leakage and yet not enough to cause appreciable waste of power.

And, too—holes cost nothing so you get more feet of packing to the pound than with solid packing. An all-purpose packing for such as Steam, Air, Ammonia and Hydraulics.

Write us—to Department M—and get our general catalog that describes and fully illustrates our complete line.

Belmont Packing & Rubber Co.

Philadelphia, Pa.

New York: 99 Chambers St. **Chicago: 38 N. Franklin St.**

Agencies in Principal Cities

Crandall Packing Co.

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Manufacturers of

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Mechanical Rubber Goods

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Rubber Hose for All Purposes

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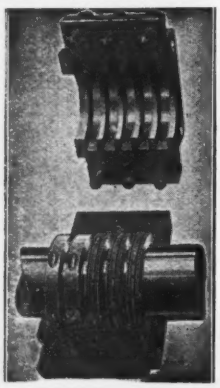

No. 31-G—Gas Packing guaranteed against 1500 lbs. pressure. 2500° Fahr.

Tell us your Packing Troubles. We please others and can please you. Nothing too hard for us. 20 years' experience—23 patents.

Holmes Metallic Packing Co.
Wilkes-Barre, Pa.

Ask for "Holmes" Pkgs.

The largest plant devoted exclusively to Metallic Packing in the world

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A Trial Will Be Convincing

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Quality Packings Manufactured by the

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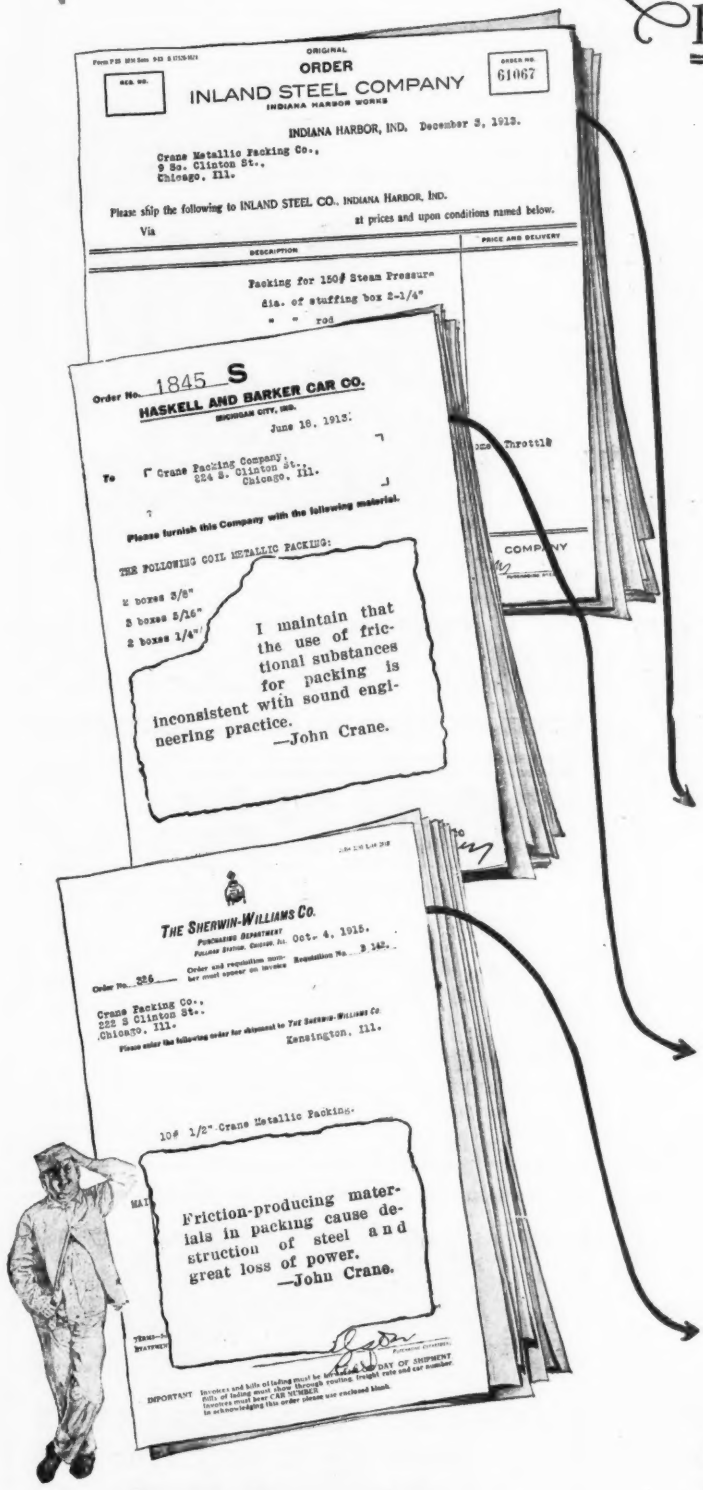
Repeat Orders Prove Packing Satisfaction


ORDER
INLAND STEEL COMPANY
INDIANA HARBOR WORKS
61067
INDIANA HARBOR, IND. December 3, 1913.
Crane Metallic Packing Co.,
9 So. Clinton St.,
Chicago, Ill.
Please ship the following to INLAND STEEL CO., INDIANA HARBOR, IND.
Packing for 150# Steam Pressure
Order No. 1845 S
HASKELL AND BARKER CAR CO.
MICHIGAN CITY, IND.
June 18, 1913.
Crane Packing Company,
224 S. Clinton St.
Chicago, Ill.
Please furnish this Company with the following material.
THE FOLLOWING COIL METALLIC PACKING:
I maintain that the use of frictional substances for packing is inconsistent with sound engineering practice.
—John Crane.
THE SHERWIN-WILLIAMS CO.
Oct. 4, 1915.
Crane Packing Co.,
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Chicago, Ill.
Kensington, Ill.
10# 1/2" Crane Metallic Packing.
Friction-producing materials in packing cause destruction of steel and great loss of power.
—John Crane.

Today, "John Crane" Metallic Packings are firmly established.

They are sound in principle and construction. The right materials are used. They have given perfect satisfaction.

The largest industrial plants, where packing bills run into thousands of dollars each year, have recognized the "John Crane" line as a means of reducing their packing costs.

Overhauling, repairing and replacement of *rods, shafts* and *plungers* is the large packing cost. Production losses, due to shut-downs, is another Power losses, due to unnecessary friction, is the third. Overtime is the fourth. Packing satisfaction is reducing these costs to a minimum.

1913 to 1921

The Inland Steel Co. have used "John Crane" everywhere in their plant. On *hand valves, header valves, expansion joints, high pressure hydraulic pumps, accumulators, outside packed plunger boiler feed pumps,* and *large water works plunger circulating pumps.*

1913 to 1921

The Haskell & Barker Car Co. have used "John Crane" consistently on *high pressure hydraulic triplex pumps, high speed air compressors, Corliss valve stems* and *large mill engine piston rods.*

1915 to 1921

The Sherwin-Williams Co. have used "John Crane" on *sulphuric acid, valve stems* and *pump rods. Steam rods, turbines* and *centrifugal pumps,* handling paints and liquors.

Crane Packing Company
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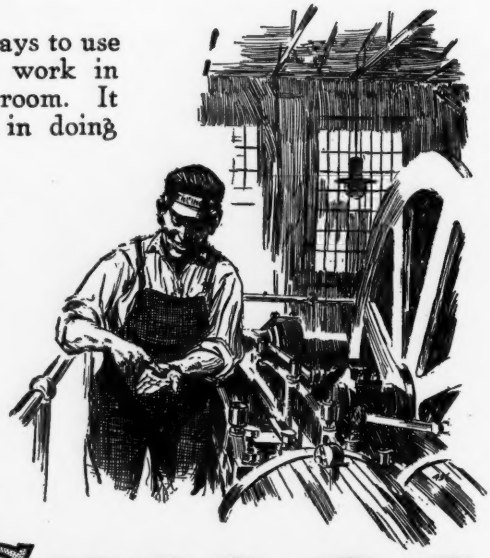
Albany Grease has proved its A-1 lubricating qualities

ENGINEERS have learned by experience that it pays to use Albany Grease. It is adapted for lubricating work in the refrigerating plant as well as in the boiler room. It does not drip or waste away, but is all consumed in doing useful work.



You owe it to your own convenience, to the efficient running of your plant, to get all the facts about Albany Grease now.

Your dealer stocks it because he knows it's good—Ask us for a sample large enough to make a real test.

Write for Bulletin PE-1

ADAM COOK'S SONS
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C-122

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A MARK
Known and Respected Around the World Since 1868 for Fair Dealing, a Quality Product and an Unexcelled Service

Albany Grease

A New Year Present From You

For more than 30 years we have been presenting you with the superior merit of good old reliable

Eureka Gum Core Packing

Many hundreds accepted our claim—that for all purposes up to 125 lbs. it needs fewer renewals—creates less friction and is very economical. They have been regular customers for years.

If you are not one of them won't you give us a **New Year Present** by ordering some from your dealer —or direct from us? We will greatly appreciate the gift and guarantee you will be pleased.

Eureka can't be beat for steam, water, air, oil, etc. It is **Especially Good for Water End of Pumps.** During the holidays you will be overhauling. **Make us a present:** Order some Eureka.

Eureka Packing Co.
79-81 Murray St., New York

SMOOTH-ON ELASTIC CEMENT No3

For Tight Joints

Screw thread joints made with SMOOTH-ON ELASTIC CEMENT No. 3 are surely made, not "maybe" made. SMOOTH-ON expands as it sets —seals the tiny irregularities that ordinary jointing compounds never catch. Order a 5-lb. can today from your Supply House.

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THE best and most economical lubricant for every purpose—is made in several grades suitable for all conditions.

The only practical method of determining the relative efficiency and economical results of the many lubricants marketed today is to enter a trial order for

OHIO Cylinder Grease

—no obligation incurred.

Write us for further particulars

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GREASE

Makes the most efficient equipment more efficient

The Keystone Lubricating Co.
Executive Office and Works:
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Established 1884 Agencies in Principal Countries throughout the world

FLEXMET

"Metal Hose Flexible Like Rubber"

FLEXIBLE METAL HOSE

For highest steam pressures, superheated steam, hot and cold water, compressed air, ammonia, etc. Better, more durable, stronger and more efficient than rubber hose. Heat insulated,

by asbestos and armor, where desired. The best hose for power-plant use. Supplied complete with fittings for any purpose whatsoever.

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BREEZE METAL HOSE & MFG. CO., Inc. 1904
Distributors Wanted
253 South Street, Newark, N. J.

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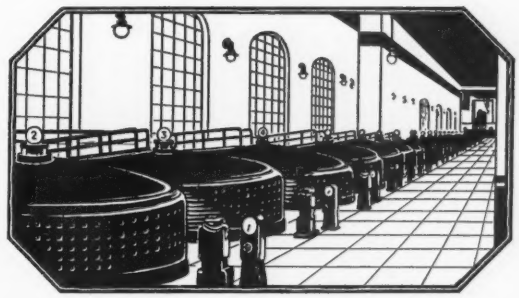

Quality Plus Service

Our Superla Brands are the finest oils we manufacture. They represent the superlative in lubrication.

We unhesitatingly guarantee them to have no superior.

In addition to the superior service rendered by Superla Oils, we maintain a staff of specially trained lubricating engineers, whose business it is to consult with and advise plant officials on problems relating to their specialty.

When you use Superla Oils you get not only the highest quality lubricants obtainable, but also you have at your disposal, the services of men who are authorities on lubrication.

We invite you to make use of this advisory service—just write us and one of our specialists will call upon you for consultation.

The Service Is Free

Standard Oil Company
(Indiana)
910 So. Michigan Ave., Chicago, Illinois

7 Warnings!

How your bearings protest against incorrect lubrication

Bearings use a language of their own to tell you their troubles. It is a language engineers know—a language every man who wishes to keep down operating costs and increase production profits will understand.

1 **Hot Bearings:** warn you (in most cases) of friction damage traceable to incorrect oils or the incorrect application of any oil.

2 **Rapid Wear:** warns you that depreciation through incorrect lubrication is an item that must be figured as an expense.

3 **Scoring or Cutting Bearing or Journal Surfaces:** warn you of partial shutdowns entailing expensive repairs.

4 **Seizure:** warns you that a shaft, frozen through incorrect lubrication, is beyond the help of any lubricating oil, good or bad.

5 **Wiping:** warns you that Babbitt metal cannot withstand incorrect lubrication.

6 **Waste of Oil:** a warning that you are using oils of low lubricating value, or applying oil by wasteful methods.

7 **Waste of Power:** a warning commonly overlooked. Poorly lubricated bearings call for more power. More power calls for more fuel. More fuel costs your Company more money. Production profits suffer in consequence.

Not one of these warnings can safely be ignored.

VACUUM OIL COMPANY

Are any bearings in your plant giving warnings?

Some of these warnings are as plain as a semaphore on a railroad block. Others—as in shafting—you have to climb a ladder to see. Others—like power waste—require a second thought to appreciate. Others—like oil waste—are self evident.

The Vacuum Oil Company for more than 50 years has been helping plant owners and engineers to heed the warnings that bearings give, and to apply the specific remedy—Correct Lubrication.

The results of our manufacturing and field experience in plants of every size on engines and machines of every type are at your service.

We suggest that you get in touch with our nearest branch.

To make it possible for you to get *prompt results* with correct lubrication, stocks of Gargoyle Lubricating Oils are carried in principal cities throughout the country.

To anyone seeking authoritative facts about Bearings and their Lubrication, we will mail free on request an illustrated copy of our Bearing Paper. It discusses:

construction of bearings,
various conditions under which they operate,
various systems by which oil is applied,
principles of lubrication,
treatment of frictional heat,
manufacture, physical properties and selection of oils,
properties and use of greases,
typical bearing troubles and their remedies, etc., etc.

For copy of this valuable booklet, address our nearest branch.

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GARGOYLE

Lubricating Oils

A grade for each type of service

For Lower Production Costs

Steam Cylinders

Gargoyle Steam Cylinder Oils minimize power losses and undue wear in steam cylinders the world over. No other steam cylinder oils are so widely endorsed by engine builders.

The well-known Gargoyle Cylinder Oil 600 W and several other Gargoyle Lubricating Oils are specially manufactured for cylinder and valve lubrication to meet conditions in all types of Steam Engines, Steam Pumps, Steam-driven Compressors, Locomotives, etc.

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A worry of every turbine operator is sludge. Gargoyle D. T. E. Oils are manufactured and especially treated to meet the exacting requirements of turbine lubrication. These oils separate readily from moisture and impurities and thus provide remarkable freedom from sludge.

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The severe lubricating requirements of gas engines, Diesel engines and oil engines are scientifically met by Gargoyle D. T. E. Oils.

Compressors and Vacuum Pumps

Correct lubrication is of unusual importance in compressor work. Carbon in the air cylinder has sometimes caused explosion. Gargoyle D.T.E. Oil Heavy Medium is made especially to minimize carbonization. It is correct for air or gas compressors and vacuum pumps.

Bearings

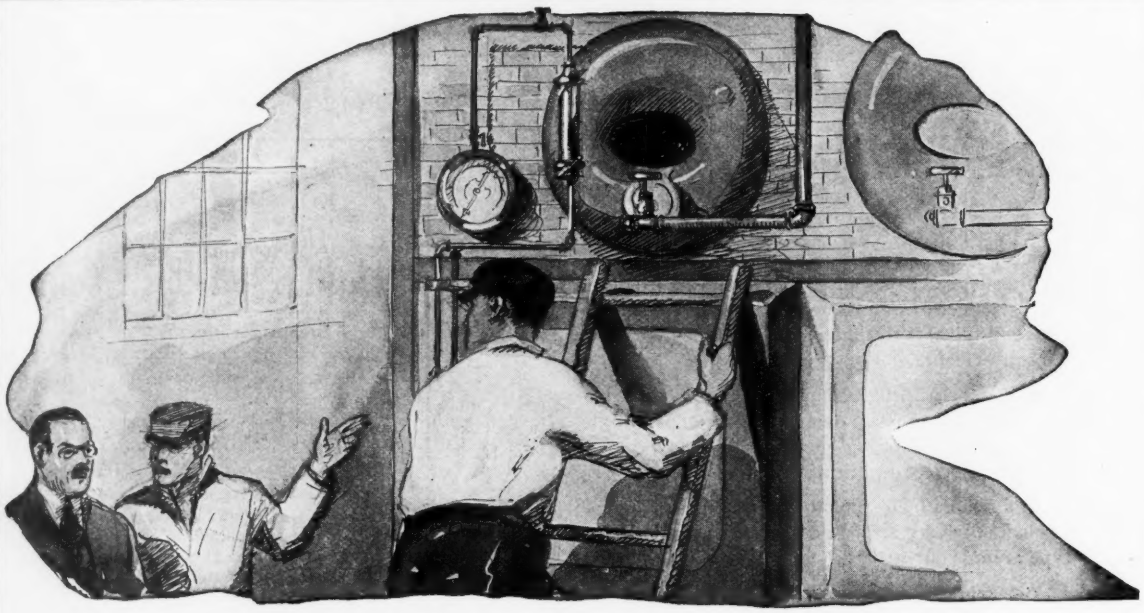
A wide range of Gargoyle Bearing Oils is provided to meet all specific operating conditions of engines and machines involving size, speed, pressure, temperature and lubricating methods.

* * *

THROUGH our nearest branch or distributor, we shall be glad to assist you in selecting the correct Gargoyle Lubricating Oils for use throughout your entire plant.

Stocks are carried in principal cities throughout the country.

VACUUM OIL COMPANY



"Boilers Absolutely Free from Scale"

DIXON'S PIONEER BOILER GRAPHITE

"Ever since we started using Dixon's Boiler Graphite it has been an easy matter to keep these boilers free from scale," said the Chief. "Dixon's has been a great saving to our plant. It means less money spent cleaning scale from the boilers, and less coal consumed to get the required power.

"Yes," continued the Chief, "this particular flake graphite lessens the grip of the scale, and each application is a stronger prevention against new scale baking solidly to the metal. Why, we've cleaned our tubes with half the men and in one-third the time; and as for drums, one man can clean them in a day with a wire brush."

"I am mighty glad I wrote for that Dixon Booklet," said the G. M. "If other companies would do the same they would soon see how to lower their power costs."

Have you received your copy? It is Booklet No. 96T, "Graphite for the Boiler."

Joseph Dixon Crucible Company
Jersey City, New Jersey
Established 1827

We also make
- ☐ Cup Grease
- ☐ Joint Compound
- ☐ Silica-Graphite Paint
- ☐ Waterproof Grease
- ☐ Flake Graphite
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- ☐ Boiler Graphite

Write for catalog. Mark X in square

"Sufficient Lubrication"

The Goal of the Best Mechanical Practice

SUFFICIENT Lubrication—the ideal condition—implies just enough of the right kind of oil.

TOO MUCH oil may be as bad as too little—for too much oil means waste of lubricant and, in some types of lubrication, brings about other troubles more costly than the mere waste of the oil itself.

*

Texaco Lubrication Engineers are trained to spread and practice the Doctrine of Sufficient Lubrication.

They are ready to cooperate with you or your employes.

They will, if necessary, make a mechanical survey of your equipment and recommend the scientifically correct grades or brands of Texaco Lubricants to meet the conditions.

They will not stop there

They will work with you to determine the correct amount of oil to bring about sufficient lubrication.

In some instances they may even recommend the use of a little more oil, but in most cases we think that they will be able to show you how to accomplish better results with less oil consumption—and sometimes with even less of the Texaco Oils you are using.

There is nothing altruistic about this.

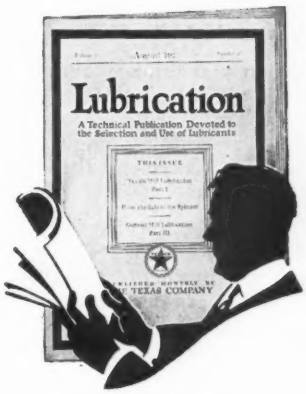
This may be called enlightened self interest.

Indeed it is a far-sighted policy

For even if you use a little less of our oil THIS year, the economies secured will make it more certain that you will use Texaco Lubricants next year—and some years after.

We are in business for the long pull.

There is a Texaco Lubricant for every purpose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A Technical Publication Devoted to the Selection and Use of Lubricants
THIS ISSUE
PUBLISHED MONTHLY BY THE TEXAS COMPANY

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"Lubrication" is our monthly magazine in which we print articles covering the problems of lubrication as applied to various industries.

These articles are based on practical operating experience. We send it Free to all interested in the subject.

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Kindly put my name on your Free mailing list for "LUBRICATION."

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12-15

What Does BUNDY Service Mean—to You?

Something of value in every instance. Bundy Trap users call upon it whenever they have a trapping problem to be solved. Because Bundy Service is essentially an Engineering Service, specializing exclusively in all that pertains to trapping and doing so day after day and year after year.

When you think about it, Bundy Service is of almost incalculable value. Most Bundy Trap users are competent to handle, within a certain range, their own trap problems. Outside of those boundaries they may need help.

But Bundy Service is never at a loss—ever able to help. There is probably no trapping problem possible that Bundy Engineers are not familiar with. It has been their life work to meet, to anticipate and to conquer trapping complexities. Concentrated ability such as this exists **only** in the Bundy Organization, and is maintained **solely for the benefit,** free of charge, of Bundy Trap users.

Bundy Service begins and demonstrates its worth before the Bundy Trap is sold. It starts by saving Bundy customers thousands of dollars of needless initial investment.

If not already Bundy Trap users, most customers are apt to base their requirements on ordinary trap standards of rated capacity.

They do not know, of course, that Bundy Traps have from 2 to 10 times the capacity of most other traps. **That Bundy ratings represent actual capacities.** That Bundy Traps have **full openings.** That, unlike other traps, the Bundy Trap has no reduced areas to impair or curtail its discharge capacity.

But Bundy Service knows these things and knows just the types and sizes of Bundy Traps to fully satisfy the customer's needs. They will be **much smaller traps—much less costly traps**—perhaps **fewer traps**—but they will do his work perfectly, and we will guarantee the result.

At this stage Bundy Service has only begun. It follows with proper installation, assures correct operation and, during all the years the Bundy Traps are used, is at the owner's command any day or any hour.

Bundy Service is based upon mutual interest. When we help our customers we help ourselves. Satisfied Bundy customers exceed in value any advertisement we can write.

May we send you, free, the Bundy Trap Book "E." Simply send your name and address.

New Bundy Three-Valve Pumping Trap

THE STEAM TRAP BUNDY WITH A PAST AND A FUTURE

NASHUA MACHINE CO., Inc.

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General Offices and Factory: 39 Elm St., Nashua, N. H.

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A Perfect Steam Trap

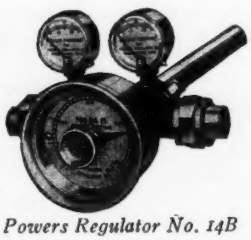
Large Capacity—Quick Action

The Powers High Pressure Steam Trap (¼ Actual Size)

Here's a small, compact, and extremely efficient trap, suited to apparatus using high pressure steam for its heating properties—sterilizers, vulcanizers, dryers, enameling ovens, steam kettles, steam tables, etc., etc. Constructed on the vapor disc principle, by expert builders of thermostatic vapor discs. Quick Action. Opens **wide.** Closes **tight.** Guaranteed. Made only in ⅜ in. and ½ in. sizes.

Specify your steam pressure and pipe size, and we'll send you a **Powers** for a 30 days' free trial. It's sure to sell itself if you want a good trap.

Anyway—get our Bulletin 115.



Powers Regulator No. 14B

This Automatic Heat Regulator

—applied to pasteurizers, sterilizers, steam cookers, drying and cold storage rooms, japanning ovens, etc., assures a constantly even temperature. It is extremely sensitive to thermostatic changes, is accurate and reliable.

Man's judgment may err; the thermostatic machine, never. Therefore, substitute automatic control wherever possible.

Our Bulletin 132 gives further details.

Wherever heat is used, unless it is automatically controlled, there is waste of fuel, material, and labor, as well as lowering of standards. Why permit such waste and loss?

Put your heat control problems, large or small, up to us. We know the answer, or will find it. That's been our sole business for over thirty years.

THE POWERS REGULATOR CO.

Specialists in Automatic Heat Control

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(1227)

An opportunity to broaden your knowledge of steam traps.

You get your knowledge of power plant practice either by hearsay, by reading or by actual experience. There is no questioning the practical knowledge gained through experience—but often experience is expensive.

Here is a chance to learn by experience without investing a cent—

The offer we make is not a "free trial". We merely ask the privilege of demonstrating the Armstrong Steam Trap to engineers who have had sufficient experience to recognize steam trap merit.

The "Request for Test" (below) differs radically from a free trial in that you agree to examine and test the Armstrong Trap and then **return it**—the demonstration to have cost you nothing.

Why we make this offer—

The purpose of this offer is not to sell a trap, but to put the merits of the Armstrong before men who are buying traps and who are influencing the buying of traps—put it before them in the proper way; not on paper, but right in their hands where they can examine its construction and test its operation in actual service.

Know the many advantages—

Can you refuse this opportunity to investigate the Armstrong submerged bucket principle; the non-airbinding feature; the quick action and self-scrubbing features; the extreme simplicity which permits highest quality at lowest first cost—and the many other widely praised Armstrong features?

If you use steam traps mail the "Request for Test."

Armstrong Machine Works
310 Maple St., Three Rivers, Mich.

Armstrong Steam Trap

REQUEST FOR TEST

PPE-12-15-21

To ARMSTRONG MACHINE WORKS,
310 Maple St., Three Rivers, Michigan.

Please ship, charges prepaid, an Armstrong Steam Trap, per specifications below, for test purposes. It is understood that this trap may be retained at least ninety days in order to test its various features and that when the test is completed the trap is to be returned to the Armstrong Machine Works, charges collect.

Size of trap.....Size of pipe connections.....*Pressure....

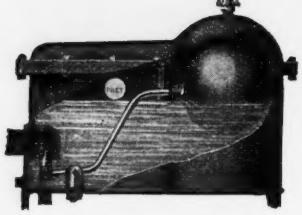
*Important—Do not neglect to state maximum pressure on trap.

Ship to.....

Address .....

Signed..... Position.....

EMPIRE STEAM TRAP



For Low Pressure Service

The Empire is especially designed for all work up to twenty pounds pressure and meets every requirement for this service. Its extreme simplicity and accessibility appeal to the man who wants top-notch results and dollar-for-dollar value. It is the result of forty years experience in building steam traps.

If rate of inflow exceeds outflow, the discharge will be constant. For this reason, the Empire is known as a "continuous flow trap." Should this condition be reversed, the float tightly closes the valve, preventing escape of steam. Air is removed by the long air valve at the trap's highest point. Write for special folder and prices.

in underground or interior heating lines.

AMERICAN DISTRICT STEAM COMPANY

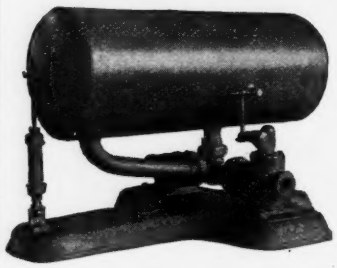
GENERAL OFFICES AND WORKS
NORTH TONAWANDA, N.Y.
BRANCHES:

30 Church St. New York | First National Bank Bldg. Chicago | Hoge Bldg. Seattle

Ask about Adsco Heating for building groups from Central Station steam plant—Bulletin 20-PP; for individual buildings, Bulletin 150-PP. We manufacture all material and equipment used

ADSCO

The ELLIS Automatic Tilting Steam Trap



Larger Handling Capacity

Simplicity of Construction

Certainty of Action

Absence of Repair Bills

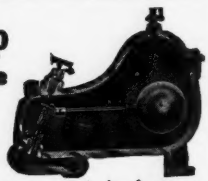
Are not these facts convincing enough to make the practical engineer look further into this trap?

Write us today.

4 Types: Direct Return—Lifting—Vacuum—Separating

The Ellis Drier Company Roosevelt Road and Talman Av., Chicago

McDaniel Steam Trap
for High or Low Pressure



The Trap that holds the Steam and removes all condensation from the steam pipes, steam cylinders, steam coils, jacketed kettles, steam separators, heating coils, and, in fact, at any point where water of condensation will collect. Steam can't blow through, they have large discharge valves and cannot be flooded with sudden flushes of water. Send for our yellow booklet that will tell you more about the Trap, or better still, let us send you one on 30 days' trial and you can see what a steam saver this Trap is. They pay for themselves.

Watson & McDaniel Co., 148 N. 7th St. Philadelphia, Pa.

The Genuine Squires

Steam Trap

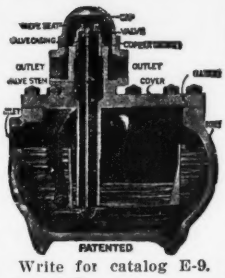
Trade Mark

Prevents Waste

Because of superior design, fine workmanship, and high quality of materials used, the Squires for a quarter century has held undisputed supremacy with progressive engineers. All parts accessible and interchangeable.

Dependable, durable and efficient—qualities common to all Squires Steam Specialties.

For economy, try one in your own plant.

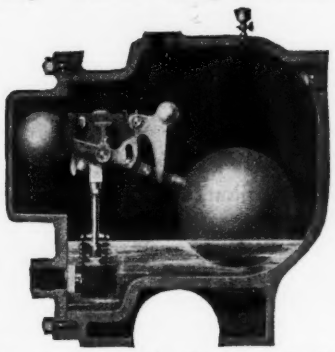


Write for catalog E-9.

The C. E. Squires Company
E. 40th St. and Kelley Ave.
Cleveland, Ohio

For Service

50% to 100% Larger Discharge Capacity Than Any Other Trap



No dependence whatever is placed on the buoyancy of the float to lift the WYOMING'S discharge valve from its seat, as is the case in all other float or bucket traps. The float is instrumental only in releasing the valve weight which, in dropping, lifts the discharge valve. This is the reason that the capacities of the WYOMING are so much greater than other traps which depend on float or bucket to open the valve.

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Positive discharge—non-wire-drawing, water-sealed discharge valve. All working parts are attached to the cover, which can be easily removed.

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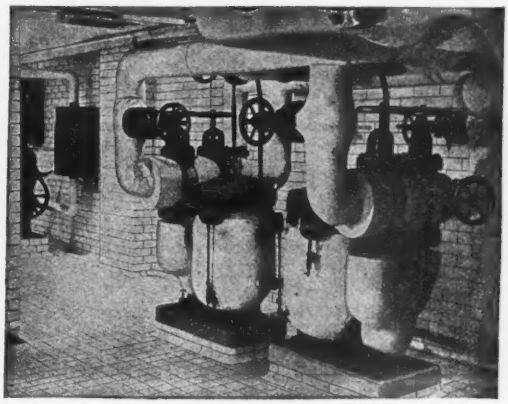

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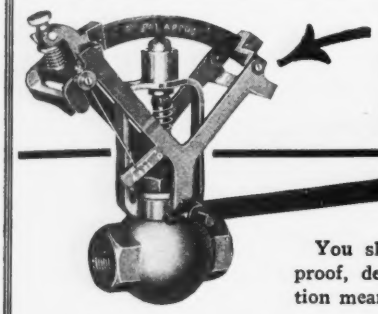

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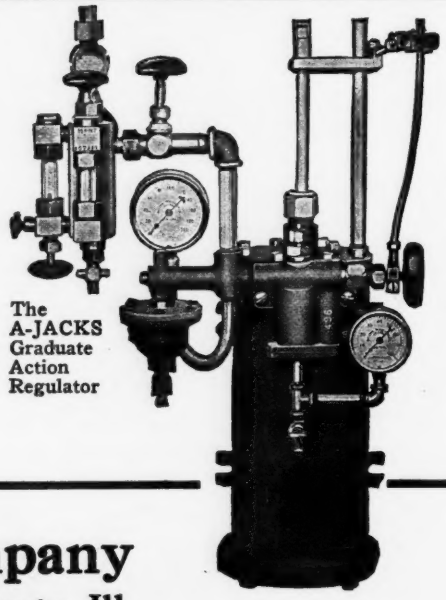

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are used by the leading Combustion Engineering Concerns for controlling dampers and speed of Fan Engines or Blowers. *Write for Bulletin A-3.*

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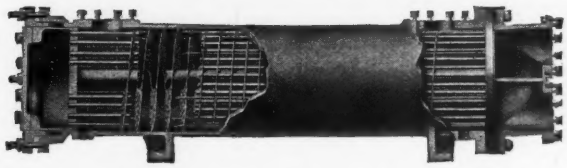

IN the heat treatment of steel, it is necessary to cool the quenching oil in order to secure uniform results in quantity production and to permit the carrying on of the quenching operation without interruption. This also permits the use of a lighter and much cheaper oil because the bath is safely kept below the lower flash point.

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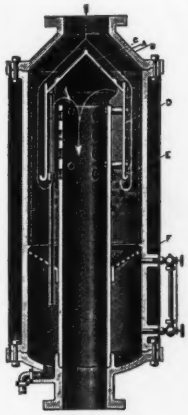
Even a small quantity of water in the steam in your engines may break valve, cylinder head or piston—sometimes all three. But there is a way to remove that water.



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delivers steam to the engine 99.8% dry, without losing a single pound of pressure. Your engine is sure to give better service, your coal bill will be cut down with a Sweet's Steam Separator.

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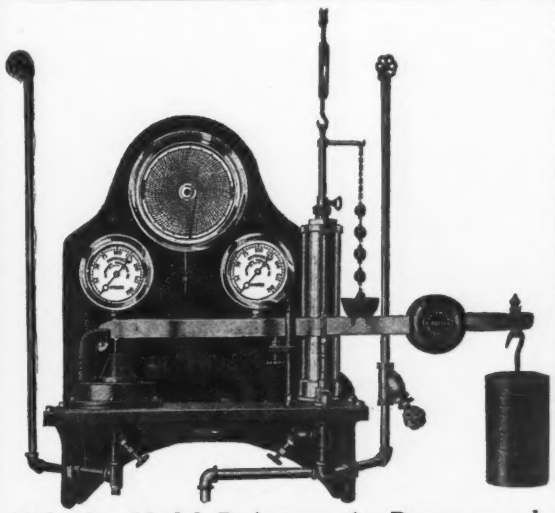

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To make machine a positive Regulator all that is necessary is to lift off the ball weights.

All Cast Iron parts are of Stove Iron Castings. Baked on Black Enamel; mounted on Cast Gauge back, with 5-in. Steam and Water Gauges, and 8½-in. Recording Steam Pressure Gauge. Front parts are all nickel plated.

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in both name and performance. It eliminates the danger of boiler explosions and will materially slash into fuel bills by constantly and automatically maintaining the water level within one-fourth inch of middle gauge. Load or methods of firing have no effect on the results it gives.

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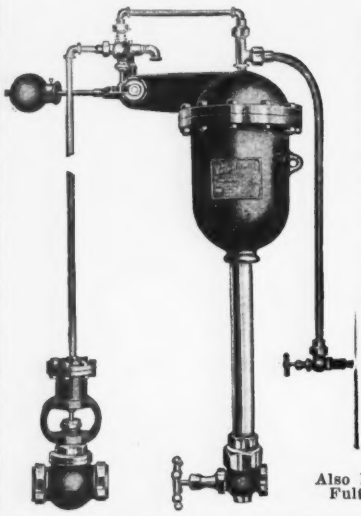

Far safer and much more economical than the unreliable hand regulation. Our long list of users, which includes nearly all the iron and steel producers in the country, is sufficient proof of the Vigilant's reliability and satisfaction.

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The "S-C" Regulator Mfg. Co.

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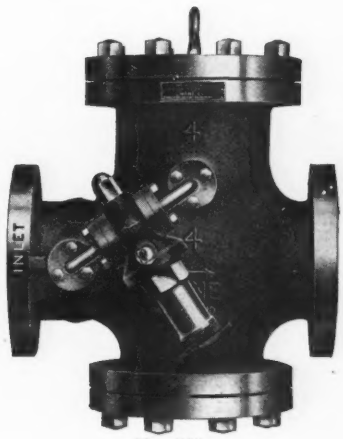
Feed Water Regulation Engineers

Accurate automatic pressure regulation is assured by the use of



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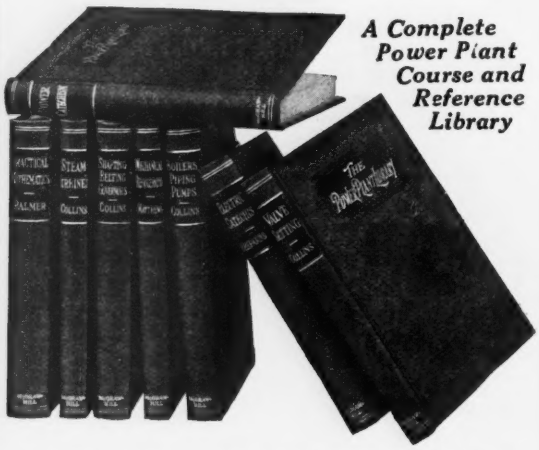

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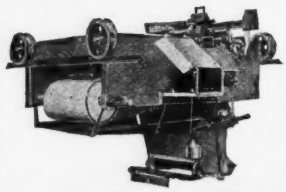

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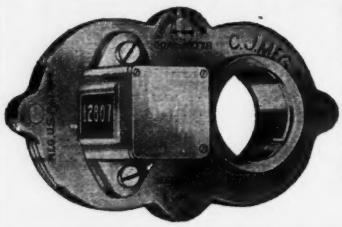

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Hays Automatic CO_2 and Draft Recorders pay for themselves in a short time out of savings they bring about.

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As Mason Products automatically and dependably operate so do they just as automatically reduce fuel bills, decrease labor and add years to the life of the equipment on which they are installed.

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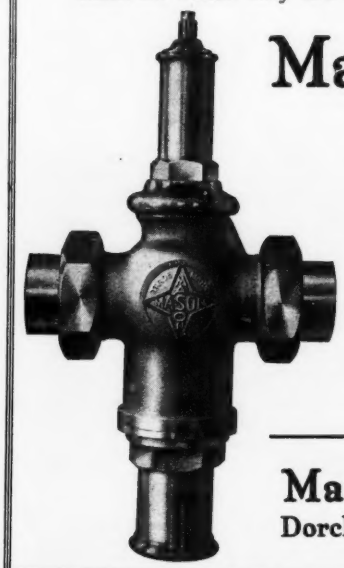

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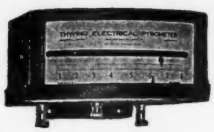

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They extract the moisture by hurling steam with centrifugal force against a perforated copper sheet. All water it contains passes through the perforations and collects in a lower chamber out of the steam flow. None can come back into the steam.

Strong Separators are made in vertical and horizontal types. **Practical** and **efficient** in service. Even sizes, 3 to 10 inches, inclusive.

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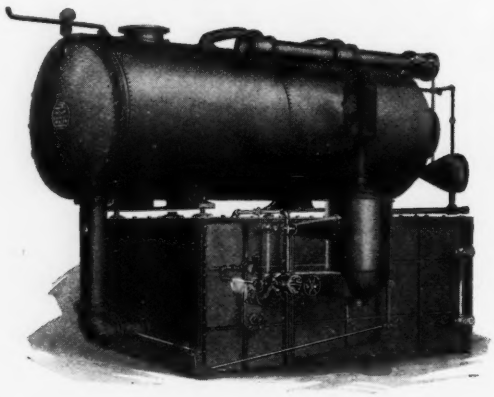
Sarco Company, Inc., 230 Broadway New York

Buffalo Chicago Cleveland Detroit Philadelphia

A Sure Check on Boiler Efficiency



HOPPES V-Notch Meters

Correct metering of the feed water offers a practical way to get at the bottom of combustion losses. Without the accurate information which the Hoppes V-Notch Meter assures, it is impossible to know the results being obtained from coal, boilers and men.

The name Hoppes is a guarantee of the service which is necessary to fully safeguard against excessive operating costs and maintenance charges. It always assures accuracy as long as the meter is used, meeting all requirements of quality, reliability and endurance. There will be less fuel wasted in your plant this winter if a Hoppes Meter is installed to guard each boiler feed.

Hoppes V-Notch Meters are equally valuable for weighing large turbine condensate, boiler blow-off and other hot or cold liquids.

Chart Side of Hoppes Recorder Head

On request the Hoppes Catalog will be promptly sent for your attention. This valuable book gives full description and details of the simple engineering principles and fine construction which characterize all Hoppes Specialties.

The Hoppes Manufacturing Co.

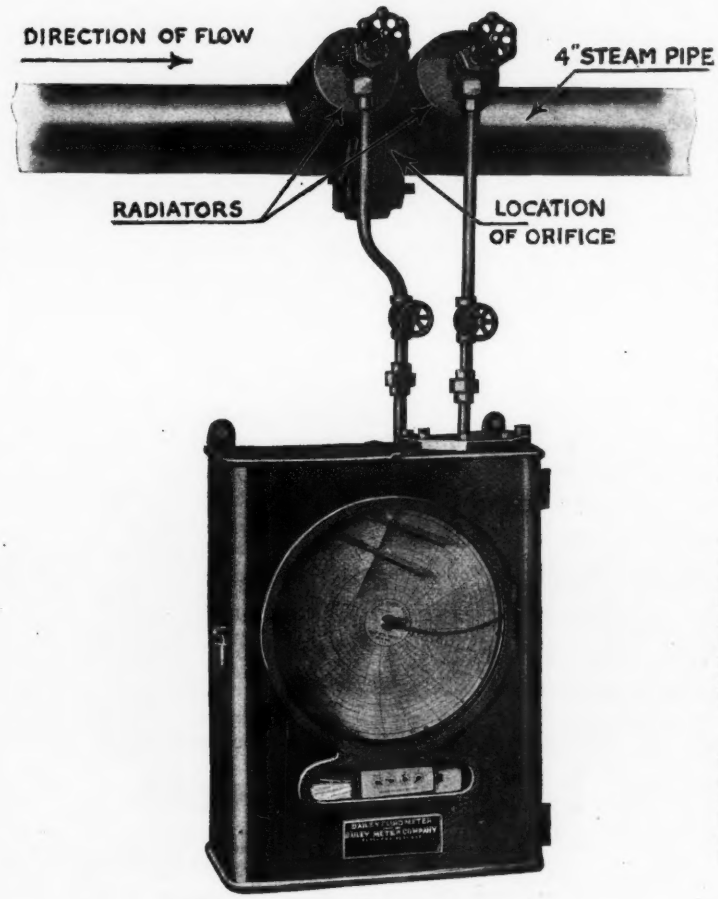
70 Larch St., Springfield, O.

We also manufacture Exhaust Steam Feed Water Heaters and Purifiers, Live Steam Feed-Water Purifiers, Steam Separators, Oil Eliminators and Exhaust Heads.

Indicating and Integrating Side of Hoppes Recorder Head

BAILEY FLUID METERS

For Accurately Measuring Steam Consumption



Accurate instruments of measurement are fast taking the guesswork out of operation. Prime mover efficiencies are now easily determined and improved upon. It's a simple matter to make sure you are constantly getting the horsepower or kilowatt output for the steam used.

Bailey Fluid Meters supply the final information that tells the tale of efficiency or inefficiency by indicating and recording the exact steam consumption independent of steam pressure, superheat or percentage of moisture.

Bailey Fluid Meters are easily installed without change in the piping. A thin, non-corrosive, Monel metal orifice, corrugated on its outer edge to obviate packing, is placed between existing pipe flanges. Radiators and valves are tapped into the pipe on each side of the orifice and connected to the recorder.

The Bailey orifice principle is in several ways superior to the Pitot tube, nozzle and Venturi tube types. It is cheaper to install, remains constant for a long period and is unaffected by differences in velocity between outer and central flow such as often occur in the swirling fluid following a pipe bend. Pressure loss seldom exceeds one pound and there is no cutting action.

Bailey Fluid Meters not only give the facts which enable you to increase and maintain the efficiency of turbines and engines, but they are also used to profitable advantage for measuring steam to various departments or for metering liquids.

Sign and send the coupon today for our latest Bulletin No. 31.

There are Bailey Meters that account for practically every factor in plant operation. Bailey Boiler Meters, Weir Meters, Gas and Air Meters, Multi-Pointer Gages, Coal Meters, Recording Tachometers, Differential Pressure Recorders, Specific Gravity Recorders and Ash Pit Loss Recorders.

Send for Bulletins on any of these and inaugurate better methods now!

Bailey Meter Company

2013 E. 46th Street **Cleveland, Ohio.**

Bailey Meter Company,
2013 E. 46th Street, Cleveland, Ohio.

Gentlemen:

Please send me your latest literature on Bailey Meters.

Name .....

Address .....

Firm .....

Insure Your Power House With a

Castle Liberty No. 1

Insurance policies do not put out fires. They only pay for the damage done by the fire. The delay caused by having to rebuild or repair damage done by fire often costs more than the Insurance Company pays.

Avoid this delay by equipping your Power House with the New Exclusive CASTLE LIBERTY No. 1, a Three-Gallon Carbon Tetrachloride Type, Hand Pump Fire Extinguisher which has sufficient capacity to extinguish almost any fire apt to happen around a Power House.

Comparative and competitive tests have proved that a CASTLE LIBERTY No. 1 can extinguish fire that could not be controlled by twenty-eight one-quart fire extinguishers.

The extinguishing agent is Castle Liquid approved for Government use and used by leading Corporations, Railroads and Governmental Departments.

Write for complete description. Write for "Safety Always" telling the real story of fire extinguishing liquids. It tells you why so many one-quart extinguishers are out of service by reason of corrosion and it tells you how Castle Liquid corrects this trouble.

Active sales representatives desired for unoccupied territory.

James M. Castle, Inc.
812 Lincoln Bldg., Philadelphia, Pa.
Manufacturers and Distributors of Fire-Fighting Apparatus.

ANY BOILER SCALE IS TOO MUCH. WATER FROM AN INTERNATIONAL SOFTENER CAN FORM NO SCALE.

INTERNATIONAL FILTER CO.
WATER-SOFTENING AND FILTRATION PLANTS
38 S. Dearborn Street, Chicago — Woolworth Bldg., New York

Borromite
RAPID RATE WATER SOFTENER

THE one way to have all the soft water you want—when you want it—even for peak loads without storage—24 hours service if needed.

Send for Booklet—"The Pay Balance of Scale-less Boilers"

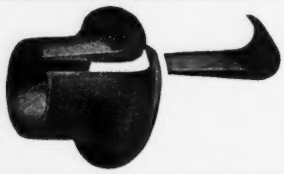
Borromite Company of America
1507—105 West Monroe Street Chicago, Ill.

By Strengthening the Weakest Part

Cruise Boiler Tube Protectors

add years of service to your boilers. Their cost is but a trifle, they are easy to attach, and they afford a practically new set of tubes. Write for particulars.

Telephone 45-R and 526-R **CRUISE & COMPANY** 144-150 Broadway ELIZABETH, N. J.



Economy is assured in many ways when

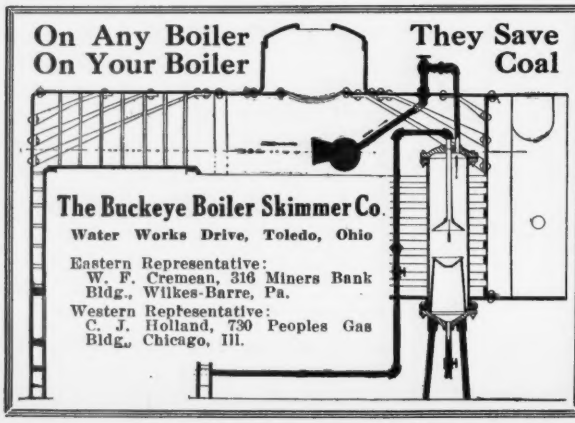
Goetze No. 2 Gaskets

are chosen. Leakless joints—steam and coal saved. Almost indestructible—cost of renewals saved. Pure copper and best asbestos give them stamina. Try some for 90 days free. What sizes do you wish?

Do not be deceived by imitations. Insist on the genuine Goetze Gaskets recognized by the quality and by the Goetze label. Also get the famous Goetze Valve Disc.

Goetze Gasket and Packing Co., 17 Allen Ave., New Brunswick, N. J.

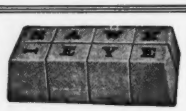
On Any Boiler
On Your Boiler
They Save Coal



The Buckeye Boiler Skimmer Co.
Water Works Drive, Toledo, Ohio

Eastern Representative:
W. F. Cremean, 316 Miners Bank Bldg., Wilkes-Barre, Pa.

Western Representative:
C. J. Holland, 730 Peoples Gas Bldg., Chicago, Ill.



Quality Makes Sales

That's the reason why

Hawk-Eye Compounds

have been in use for many years in power plants where economy reigns.

Free your boilers absolutely from scale. Write for further particulars.

Hawk-Eye Compound Co.
(Not Inc.)
Blue Island, Ill.

The True Basis of Real Efficiency in Boiler-operation

Coal, grates, draft, firemen—**all** are important factors—each within definite limits.

Feed water is the foundation that carries all. The water **must be right,** or the other factors cannot function properly. Bad feed water, making scale, causing corrosion and pitting of tubes, foaming, etc., is destructive of boiler efficiency. **Chemical Science alone** can make **bad** feed water **good** feed water.

Dearborn Treatment

is simply applied Chemical Science. We analyze the boiler feed and find out what harmful mineral salts it contains. **These** are the enemies of boiler efficiency—the cause of boiler disasters.

Dearborn Treatment is then prescribed, made up of reagents that neutralize the harmful minerals and change the water so that it cannot form scale or cause injury to the tubes.

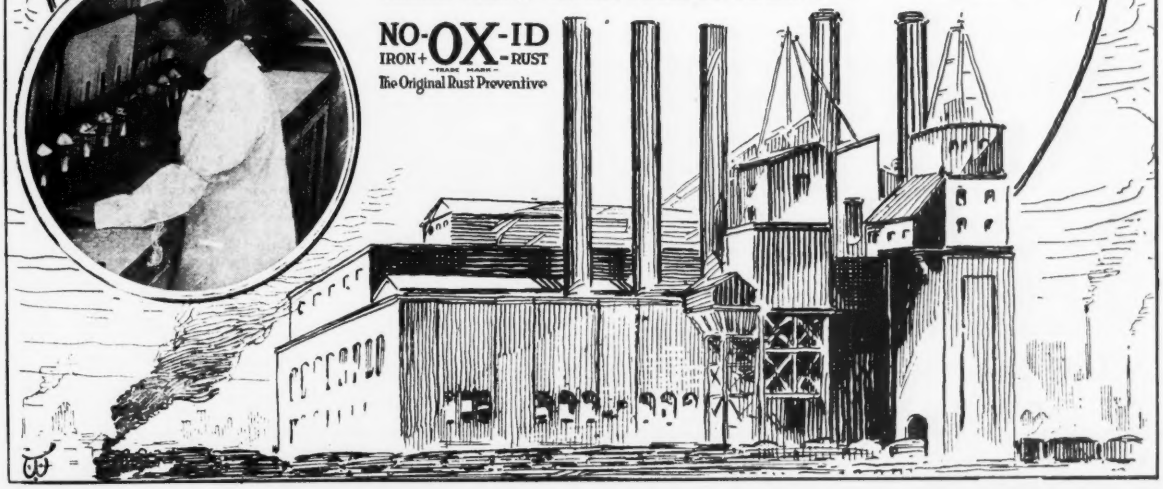
Dearborn Treatment keeps thousands of boilers permanently free from scale and working to capacity. It will do so for yours. Send us a sample gallon of your feed water. We will gladly analyze it and report details without any obligation. Write for our booklet.

Dearborn Chemical Company

General Offices, Laboratories and Works, Chicago.
General Eastern Offices: 299 Broadway, New York.
Branch Offices in Principal Cities.
Canadian Factory: 2454-2464 Dundas St., Toronto, Ont.

Dearborn
REG. U.S. PAT. OFF.

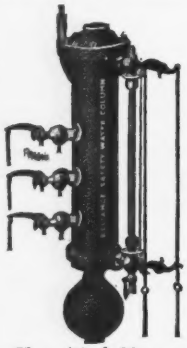
NO-OX-ID
IRON + OX - RUST
TRADE MARK
The Original Rust Preventive



DEARBORN

INDIVIDUALIZED Water Treatment

what the boilermakers think of Reliance Columns



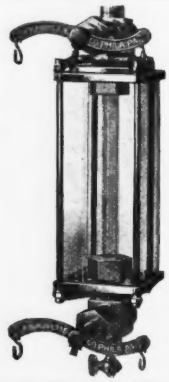
The original 35 years ago—standard ever since.

WHEN a maker of boilers, in the face of sharp price competition, equips his products with safety water columns that cost more than most columns, and makes them standard equipment, it means something.

That's why we mention the fact that a number of the largest boiler manufacturers have selected Reliance Safety Water Columns as regular equipment for their boilers. Their judgment may help you.

Reliance Gauge Column Company
5932 Carnegie Ave., Cleveland, Ohio

TRADE MARK REG. IN U.S. PAT. OFF.
Reliance
STEAM SPECIALTIES



The "P. B. H." Gauge Glass Protector

Glass used is "Safetee Glass," especially prepared to withstand shock of bursting gauge glass and will not shatter or fly if accidentally injured.

Protector cage bracket fits any make of water gauge. Illustration shows protector attached to a "PBH" chain, quick closing water gauge; an up-to-date combination for safety.

Requires but a minute to attach. In ordering, state distance between inside faces of rod plates on your gauge valves. Satisfaction guaranteed. Prices right.

Patent applied for. Write for Bulletin.

The PAUL B. HUYETTE CO., Inc.
5 So. 18th St., Suite 3, Philadelphia, Pa.

Standard in the World's Largest Power Plants

Every boiler needs a mechanical soot blower. Leaders of world industry, such as General Electric, Ford Motor, Du Pont Powder, Standard Oil, have found Diamond design and construction superior. If your boilers are not equipped, write for Bulletin 210.

DIAMOND POWER SPECIALTY COMPANY
Detroit, Michigan

Diamond
SOOT BLOWERS - SAVE 4 to 8% FUEL

VULCAN SOOT CLEANERS CO. 25 So. Brady St. Dubois, Pa.
Chicago Office: 350 No. Clark Street

Marion Equipment

Soot Blowers for water tube boilers; for fire tube boilers; Hand Fired Stokers; Marion Scottdale Grates; Marion Interlocking Grates; Marion Rocking and Dumping Grates; Keystone Rocking and Dumping Grates; Portable Kiln Grates; Forced Draft Blowers; Boiler Fronts, etc. Coal Mining Equipment; Coal Crushers, Coal and Coke Handling Machinery. Gas and Oil Engines.

Marion Machine, Foundry & Supply Company
Box 400, Marion, Indiana

A Word to the Wise

Soot is a Non-Conductor.

A Non-Conductor requires more Coal. More Coal costs Money.

Why spend Money when you can save with our

Mechanical Power Soot Scraper

Boiler Specialties Supply Co.
5 Pleasant St., Room 506, Worcester, Mass.

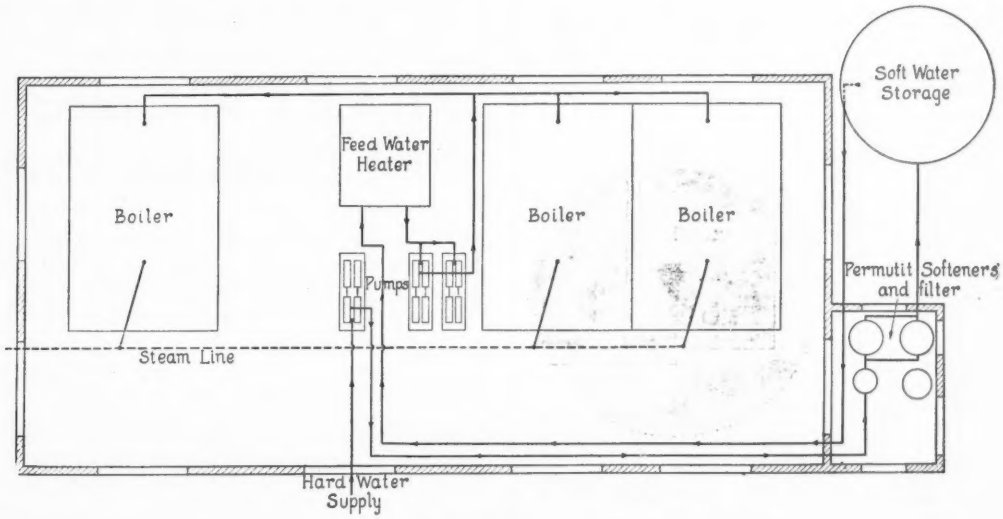
Thirteen Years' Specialized Experience at Your Service

A BAYER for every type of boiler

Successfully solving soot-blowing problems on every type and size of boiler for many of America's foremost power plants and leading boiler manufacturers qualifies us to offer you the Bayer Steam Soot Blower, not as an apparatus but as a superior solution of your particular soot problem.

Let us give you full information on our specialized designs and the savings they effect. Write today.

THE BAYER CO. 4060 Park Ave., St. Louis, Mo.



Operate at 200% Rating Yet Absolutely Free From Scale

The boiler plant of a big irrigation company in Texas consists of three horizontal water tube boilers having a total of 1100 rated boiler horsepower. Their boiler feed water comes from the Rio Grande River and contains hardness varying from 12 to 22 grains per gallon in addition to being turbid and muddy. It is very poor water for boiler feed.

Under such conditions scale formed very rapidly and it was formerly necessary to clean the boilers every three weeks. In addition tube replacements and repairs cost them considerable money, and to add to their troubles, they had foaming which made it impossible to operate the boilers at more than 75% rating.

In June, 1920, they installed Permutit Zeolite equipment that removes absolutely all hardness—all scale, sludge and mud-forming impurities—from the water supply. The results were very gratifying.

All boilers and condensers are now absolutely clean and free from scale, and are opened only for inspection, all cleaning expense being eliminated. A coal saving of between 6% and 8% has been effected, and boilers are operated at 200% rating without foaming. In spite of all variations in the composition of the hard water supply, the softened water does not fluctuate, and the company was so impressed with this performance that they placed an order for similar Permutit equipment for another plant.

Permutit equipment can solve your problems as it has solved thousands of others. All analyses and investigations free of charge. Write us today.

This booklet contains valuable information that every steam boiler operator should have. Profusely illustrated. Sent free, postpaid, upon request.

The Permutit Company
440 Fourth Ave. New York

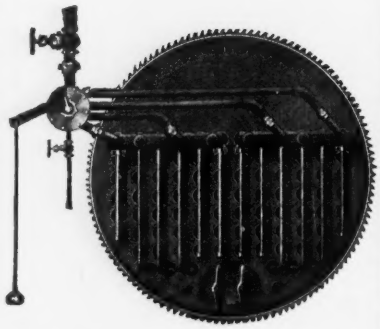
Zeolite Water Softener Patent Sustained

The Federal Court at Buffalo (Hazel J.) on June 15, 1921, handed down a decision sustaining our broad patent covering Zeolite Water Softeners. According to this decision all Zeolite Water Softeners on the market not made by us are an infringement of this patent.

No need to borrow trouble—buy Permutit—it is the best anyway.

Sootless in a Few Seconds

A thorough scouring with every particle of heat repelling soot banished from every boiler tube. One big advantage of National performance is the fact that the steam goes right where it's needed. There's no guess work—no chance of slighted tubes, as is the case where a cleaner of the swinging arm type is used.



National Flue Cleaner

consists of a series of pipes clamped on the boiler front with a patented jet before each tube. The piping is divided into sections, into each of which dry steam is admitted at the will of the operator.

When steam enters a section it drives through all jets of the section removing all soot and ash. The system is indestructible—maintenance practically nothing—performance unfailing.

In order that we can name you price, **STATE NUMBER OF TUBES IN EACH OF YOUR RETURN TUBULAR BOILERS,** also state whether uptake is in front or rear.

Write for particulars and testimonials.

National Flue Cleaner Company, Inc.
Groveville, N. J.

The End of Clogged Boiler Tubes

is at hand the minute

PILLEY'S Combination Flue Brush and Scraper

starts to work.

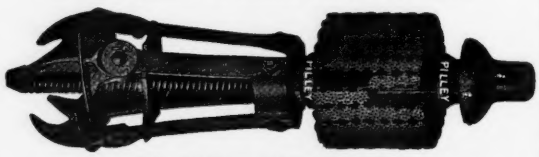
As the scraper ends expand to fit the tube, the brushes follow and sweep out all the soot and scale. Brushes are made of fine wire, which will not bend, break or pull out. No steam is used, therefore the soot cannot cake or stick.

Compact, efficient and speedy; far superior to the slow and dirty hand method.

Made in sizes for tubes 2 inches to 6 inches.

If you are interested in increasing the steaming capacity of your boiler, write us for particulars.

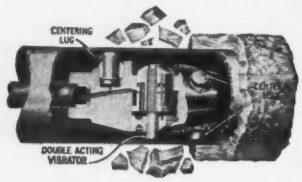
Pilley Packing & Flue Brush Mfg. Co.
611 S. Third Street, St. Louis, Mo.
Eastern Office: 71 Fulton Street, New York



Price $1.00 per Diameter Inch

Send a "Torpedo" After Scale

Sixty thousand fire tube boilers were cleaned of scale last year by the "Torpedo." It finds scale where inspectors cannot. The "Torpedo" does its work rapidly—from 2 to 4 hours per boiler—and **cleans thoroughly.**



Operated by either air or steam, it taps the tube wall lightly at the rate of 11,000 a minute. The vibrations crack and shake off the brittle scale. No injury to tubes results.

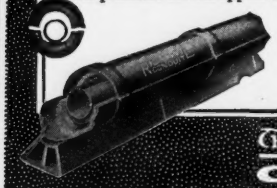
We will gladly send you a "Torpedo" for free trial on one boiler. Write us.

The General Specialty Company
72 Carroll Street - - Buffalo, N. Y.

FOR UNDERGROUND STEAM OR HOT WATER PIPES
THE ORIGINAL
RIC-WIL METHOD

The materials, constructive features, installation methods and practical results appeal with equal force to the consulting engineer, to the practical operating man and to the business executive.

Write to-day for Bulletin No. 2.



The RIC-WIL COMPANY
CLEVELAND

Clean Your Flues with the

Ruggles "Perfection" Flue Cleaner

The "Perfection" cuts away all incrustations formed by soot, ash and dirt until the flues show a perfectly clean surface, with no obstruction to passage of heat.

Smooth and easy working; over-riding such imperfections as blisters or welds. Self-adjusting and operated without hard labor. Always in direct contact with the flues. **Guaranteed to do the work.**

Write for our bulletin.

Ruggles & Ruggles, Batavia, Illinois

Cut the Cost of Cleaning Your Boilers

By Using PARAGON Hand Hole Scrapers and PARAGON Machines for Cleaning Boiler Caps

Save labor, reduce gasket costs and eliminate leaks when the boiler goes into service after cleaning.

Hand Hole Scrapers and Cap Cleaning Machines are made for all inside cap boilers, including B. & W., Heine, Edge Moor, Franklin, etc.

Send for Circular

The PARAGON Power Specialties Co. Hartford, Conn.
P. O. Box 4

Show the Boss Some Savings—He Sorely Needs Them

For years the Boss has been working under high pressure. First it was war demands. Then came urgent home demands. **"Production! Turn out the goods—figure costs later."** That's the way the Boss talked—then.

He's talking differently now. What's worrying the Boss today is not production but **"cost"** of production. Competition is fierce—only by the strictest economy can he run and break even.

Every employee can help—by greater economy and efficiency—the engineer more than anyone.

How? By producing more power while burning less fuel!

The cuts shown illustrate how the free passage of heat to the water is **obstructed** by scale-coated boiler tubes and how the full passage is **insured** by thoroughly cleaned tubes.

The record tabulated below was given to us without solicitation.

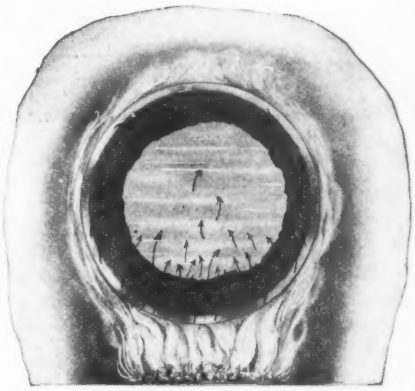
		Savings per Year	Costs per Year
Cost of Roto Type A.D. Cleaner bought 4 years ago for $110.00—cleaned over 50 miles of 4-inch tubes. (No cost for motor repairs)			$27.50
Cutter head, cutters, bolts, etc			26.05
Coal savings— Average daily fuel consumed—12 tons at $5.50 per ton. Conservatively figured at 3 per cent—yearly saving 130 tons		$ 712.80	
Labor savings— With the old cleaner it required 80 days of labor at $5.00 per day to clean all of the tubes twice a year	$400.00		
With the Roto it required 32 days of labor at $5.00 per day to clean all of the tubes four times a year	160.00		
Making a total of 48 labor days saved at $5.00 per day		240.00	
Tube savings— When using the old cleaner an average of 25 tube replacements were made per year at $10.00 per tube	250.00		
Since the Roto was adopted no replacements were necessary	None	250.00	
		$1,202.80	$53.55
Average yearly cost for Roto		53.55	
Average yearly saving		**$1,149.25**	

$712.80—over 13 times the yearly cost of cleaner and parts saved in coal.
$240.00—over 4 times the yearly cost of cleaner and parts saved in labor.
$250.00—over 4 times the yearly cost of cleaner and parts saved in failed tubes.

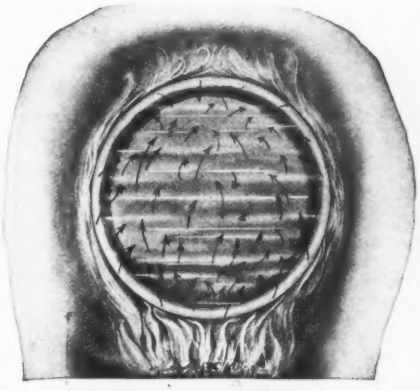
Similar Savings will commence as soon as you start using the ROTO Cleaners.

Roto is Thorough, Fast and Safe. Gets all the scale, reduces the time of cleaning, and cannot damage tubes.

Roto Cleaners are made for Fire Tube and Water Tube Boilers, Condensers, Evaporators, etc. Write for our offer to prove Roto Cleaners can make this saving in your power plant.

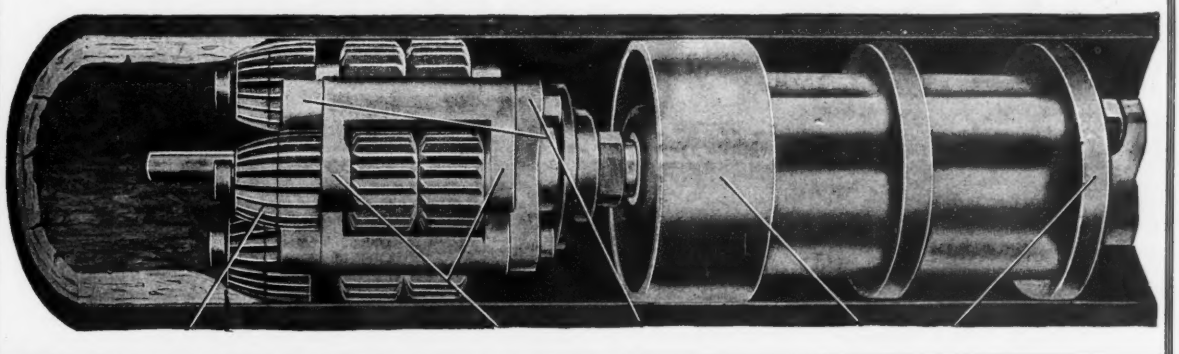


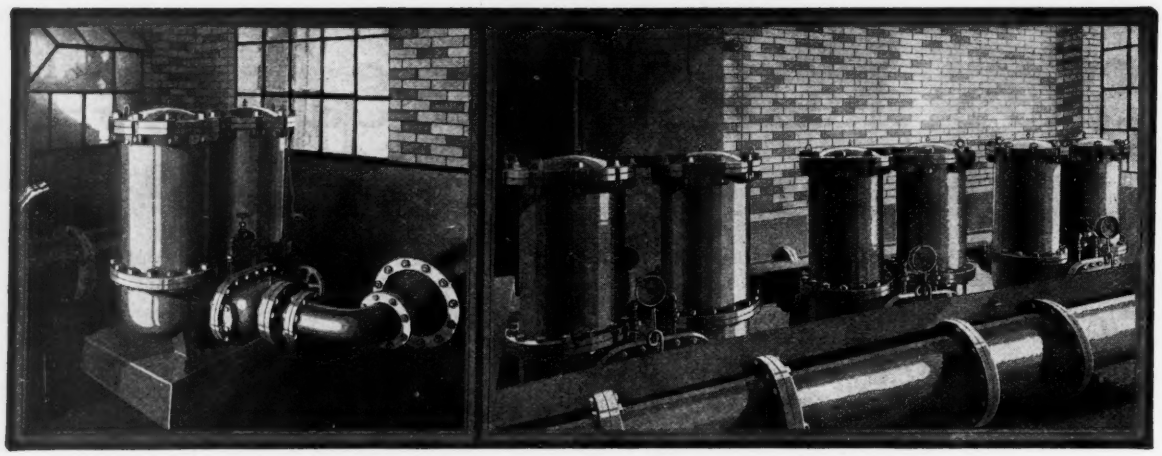
A Scale-coated Tube through which heat struggles to reach the water.



A Clean Boiler Tube through which heat passes freely to the water.

THE ROTO COMPANY 67 Temple Street Hartford, Conn.





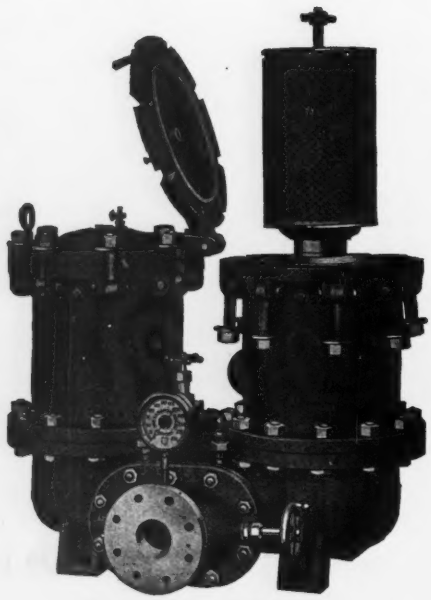
Showing four of an installation of five 6-inch Lagonda Filters and Grease Extractors at Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.

Lagonda Filter and Grease Extractors —a remarkable installation

In the manufacturing of a high grade parchment it is essential that the water used be absolutely clean and free from the smallest particles of dirt or foreign matter. The Kalamazoo Vegetable Parchment Company of Kalamazoo, Mich., have solved this problem in their plant by using Lagonda Filters and Grease Extractors. The illustration above shows a part of the installation which has been eminently satisfactory and will probably be duplicated.

As shown in the illustration below, a Lagonda Grease Extractor consists of two units, containing filtering elements in the form of a spool around which a long length of Terry Cloth is wound, the layers properly separated by a metal spacing mat. One unit is in service at a time, the other being available for cleaning. Cleaning consists of unrolling the length of cloth and replacing it with a clean length. It is quickly accomplished.

Lagonda Grease Extractors are ideal for Power Plant service in taking oil, grease or fine solid matter from the feed water. Catalog "R" fully descriptive, on request.



Lagonda Grease Extractor, one filter spool removed

The Lagonda Mfg. Co.
SPRINGFIELD, OHIO.
FUEL SAVING SPECIALISTS
NEW YORK, BOSTON, PHILADELPHIA, ST LOUIS, CHICAGO, DETROIT, DENVER, DALLAS, SAN FRANCISCO, ST. PAUL, MONTREAL, LONDON.

Manufacturers of Lagonda Boiler and Condenser Tube Cleaners, Tube Cutters, Cap and Header Reseating Machines.

R-1006

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

Beware of Greeks Bearing Gifts

This is the gift-giving season, when the very air tingles with good cheer, when the hardest heart swells with generosity and, in the name of a little Child born in a manger, the civilized peoples of the earth give to make little children happy, to bring a bit of comfort to the lowly and to renew in each other that greatest gift of all, loving-kindness.

As men in charge of the mightiest material force in the world, the millions of mechanical horsepower that make the peace and prosperity of today an infinitely higher and finer thing than the back-breaking toil of nineteen hundred and twenty-one years ago, it will detract nothing from the season's joyousness to consider the reverse side of this gift problem.

In various languages and from pagan times, cautious men, ever fighting for conquest or self-preservation, have been wary of the stranger who comes bearing gifts.

The Trojans lost their city after a ten-year siege because they failed to heed the warning to beware of Greeks bearing gifts.

"Take gifts with a sigh; most men give to be repaid," says one man; another, "Gifts are often losses," while the true spirit of giving is expressed by our American poet, "For the gift without the giver is bare."

In business, politics and industry, there is too much of that "gimme" spirit—too little of the truly giving spirit.

Men are looking beyond their own desks and are trying to visualize their business as a whole. They are looking beyond their own plants and trying to find out what is best for their whole field.

Such men are quick to see the motives of those insidious enemies of their private business, the industry in which they are engaged, or the country of which they are citizens, who come bearing gifts to gain an entrance by which they may steal many times the value of such gifts and get away with it.

A great city has just witnessed the spectacle of such gifts. Two daily papers gave thousands of dollars in prizes to holders of "lucky" coupons. Other prize contests for essays by school children are still running.

These two daily papers were to distribute two or three hundred thousand dollars in cash prizes, but they themselves surely spent other hundreds of thousands of dollars in printing of useless copies and other expenses.

What will legitimate publishers pay in higher prices of paper for those diminishing ranks of trees driven back—forests cut down to make a newspaper holiday?

Think of the millions of dollars worth of time, energy and effort given by the people of this city in checking coupons and watching this game of chance; the millions of working hours lost to business houses whose employes' minds were absorbed in the award of a few paltry prizes; the hundreds of thousands of dollars paid by merchants advertising in these papers, largely wasted because so many readers had time only to search for the winning numbers.

Mind rules the world, for from the mind all deeds, all invention, all material things must spring. From each twenty-four hours with its allotments for eating, sleeping and the routine duties of life, there is little enough time to improve the mind.

The great minds of the engineering world are studying the problems of industry. Out of this work may well be expected to come savings of waste which will many times offset the wastes of war.

Attune the mind to the new note of the times.

Listen not to the siren songs of the something-for-nothing men. They will steal thought which might be spent in acquiring knowledge. They will rob reputations of integrity by putting equipment and supplies into plants which, no matter how honest the purpose of the buyer, will prove most expensive in the long run.

Above all they sap the very foundation of character by leading people into that land of delusion where they are ever looking at the mirage of distant wealth or happiness while their feet stumble along on the desert until the journey ends and their bones whiten by the wayside.

What shall guide us, what shall we believe? Read these words from "The Nation's Business":

> People have a tendency to believe things somewhat according to the form in which they are set forth . . . When a mere average man tells us something we do not necessarily believe it at all. A statement even in a newspaper is likely to be accepted with reservations. The same statement in a good magazine is regarded as fairly certain to be true. In a book . . . we unconsciously are disposed to accept everything as authoritative.

POWER PLANT ENGINEERING aims to make each issue a periodical of current helpfulness, while at the same time, by the authority of its articles, it adds to the text-book of engineering practice which each yearly volume constitutes.

Each subscriber has paid in full a fair and fixed price for the information it contains and reads it and refers to it because he has paid for it to use as a tool of his profession.

Each advertiser found worthy of using these pages under the rigid regulations of truth, service and integrity regularly enforced by POWER PLANT ENGINEERING has chosen to offer his product and service here on the strength of the reader-character its regulations have created.

There is no "free circulation" here to win its way for doubtful ends into the minds of men; no prize offers; no secret rebates anywhere among the clientele of buyers and sellers who meet in these pages.

Beware of those who offer such.

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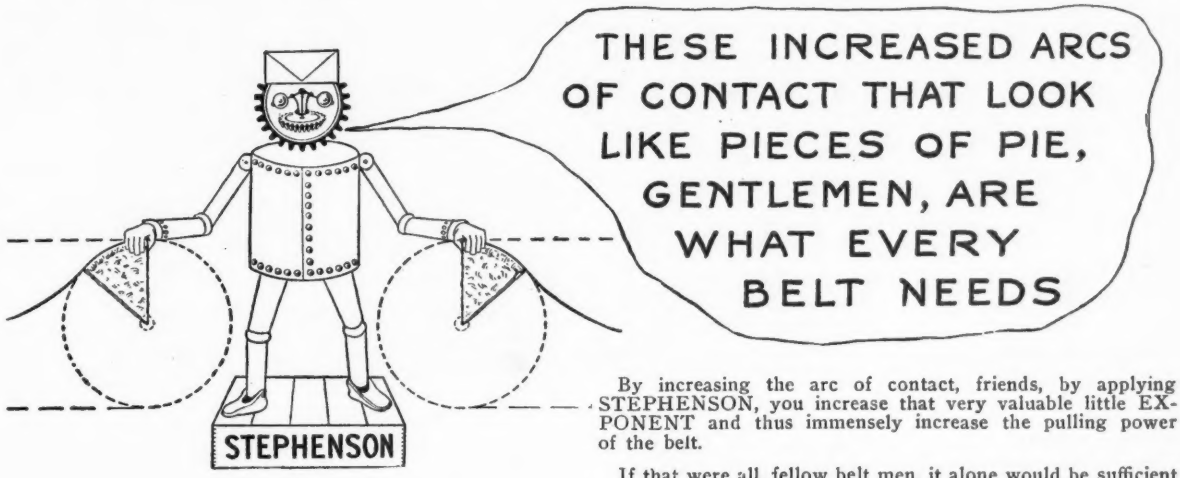
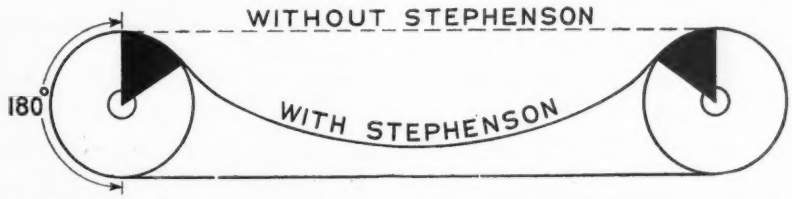
"Steve" discusses the formula $T=t\ 2.718^{af}$



The drawing below, fellow belt men, illustrates very clearly the value of slack STEPHENSON belts.

When the belt is TIGHT we have only 180° of contact. But when the belt is treated with STEPHENSON and is SLACK we have considerably larger angles of contact which I call "pieces of pie."



Has the great importance of these pieces of pie ever been brought to your attention, gentlemen? The fundamental formula for power transmission through belting is $T=t\ 2.718^{af}$, where T is the tension on the tight side, t is the tension on the slack side, a is the arc of contact, and f is the coefficient of friction.

Now, gentlemen, let us study that formula. What does it show? It shows that the tension on the slack side is LESS important than the arc of contact or the coefficient or friction. It shows that belts need NOT necessarily be tight. The arc of contact, you see, is an EXPONENT. So is the coefficient of friction.

Take the expression 10^2 for example. The 10 is merely a 10, but the exponent 2 means that the ten is multiplied by itself. 10^2 therefore equals $10 \times 10 = 100$. In the same way 10^3 is equal to $10 \times 10 \times 10 = 1000$. That little exponent, gentlemen, is very valuable. That is why I want to emphasize the fact that the arc of contact in the formula is an EXPONENT.

By increasing the arc of contact, friends, by applying STEPHENSON, you increase that very valuable little EXPONENT and thus immensely increase the pulling power of the belt.

If that were all, fellow belt men, it alone would be sufficient reason for specifying STEPHENSON on all belts, but it ISN'T all. The coefficient of friction, also, is an exponent, and its value, too, is ALWAYS increased by treating belts with STEPHENSON. By using my belt dressing, you therefore increase BOTH of the most important factors, and these factors, in the formula, as you will observe, are multiplied by each other.

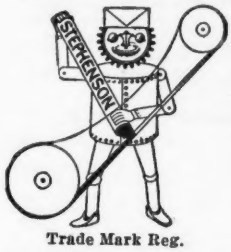
What more could you wish, gentlemen? What possible excuse is there for NOT applying my dressing to every belt, thereby increasing both the friction of the belt and the arc of contact? In other speeches in Power Plant Engineering I have told about the many advantages of SLACK belts as produced by my dressing. By referring to back issues you will find those speeches. Or, if you wish to have reprints, simply write to us for them.

OUR TRIAL OFFER. Also, why not take advantage of our trial offer? We will send you a 30-lb. box on trial for 30 days at 48c per pound. If it doesn't satisfy, and if you use less than 6 pounds, send it back at our expense. Any amount used over 6 pounds will be paid for by you. If entirely satisfactory, and I have every reason to believe that it WILL be satisfactory, you agree to pay for the 30 pounds.

OUR FREE OFFER. For those who do not want to try as much as 30 pounds we will send a half pound bar FREE. No strings attached whatever. Why not give me a fair trial? Why not add those valuable "pieces of pie" to all of your belts?

Steve

---------- TEAR OFF HERE AND MAIL ----------



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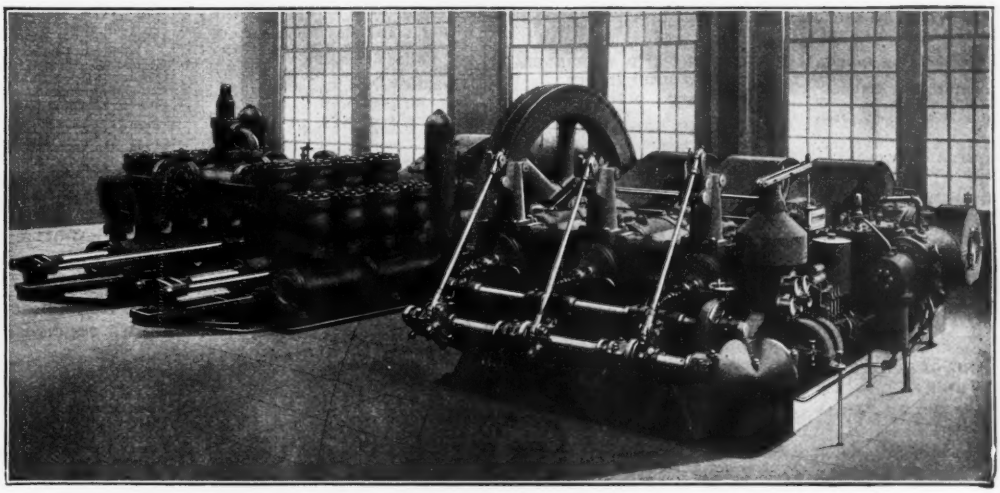

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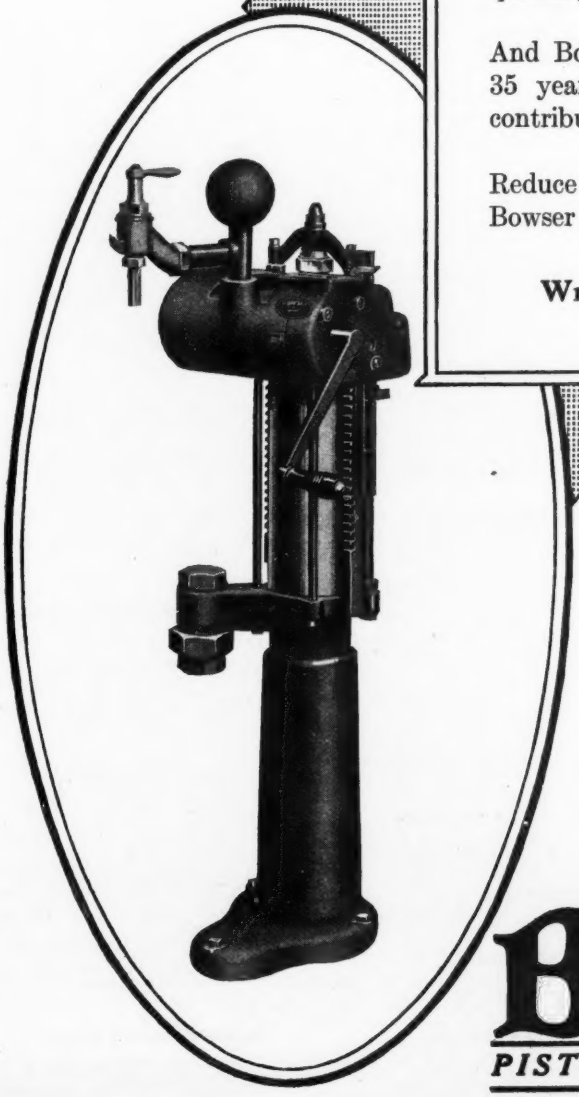

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National Flue Cleaner Co., Inc., Groveville, N. J.
Vulcan Soot Cleaner Co., Du Bois, Pa.

SPRAY COOLING SYSTEMS.

Schutte & Koerting Co., Phila.
Spray Engineering Co., Boston.

STAIR TREAD, NON-SLIPPING.

Irving Iron Works Co., Long Island City, N. Y.
Quaker City Rubber Co., Phila.

STEAM METERS.

American Dist. Steam Co., Tonawanda, N. Y.
Bailey Meter Co., Cleveland, O.
Yarnall-Waring Co., Phila., Pa.

STEAM TRAPS.

American Blower Co., Detroit.
American Dist. Steam Co., Tonawanda, N. Y.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Armstrong Machine Wks., Three Rivers, Mich.
Crane Co., Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
Elliott Company, Jeannette, Pa.
Ellis Drier Co., The, Chicago.
Johns-Manville, Inc., N. Y.
Nashua Mach. Co., Inc., Nashua, N. H.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Patterson-Kelley, New York.
Plant Eng. & Equip. Co., Inc., New York.
Powers Regulator Co., Chicago.
Reliance Gauge Column Co., Cleveland, Ohio.
Sarco Company, Inc., New York.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.
Squires Co., The C. E., Cleveland.
Watson & McDaniel Co., Phila.
Webster & Co., Warren, Camden, N. J.
Williams Gauge Co., The, Pittsburgh, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM TURBINES—POWER.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Kerr Turbine Co., Wellsville, N.Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

STOKERS, HAND OPERATED.

Files Eng'r'g Co., Inc., Providence, R. I.
Flynn & Emrich Co., Baltimore.
McClave-Brooks Co., Scranton, Pa.
Vogt Bros. Mfg. Co., Louisville, Ky.

STOKERS, MECHANICAL.

Babcock & Wilcox Co., N. Y.
Combustion Eng'r'g Corp., N. Y.
Files Eng'r'g Co., Inc., Providence, R. I.
Flynn & Emrich Co., Baltimore.
Illinois Stoker Co., Alton, Ill.
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Riley Stoker Co., Sanford, Worcester, Mass.
Underfeed Stoker Co. of America, Detroit, Mich.

STOKERS, UNDER-FEED.

Combustion Eng'r'g Corp., N. Y.
Detroit Stoker Co., Detroit, Mich.
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No sale or business transaction can take place without a "meeting of minds." Whether a block or a thousand miles separate buyer and seller, their minds must meet before goods can be sold or bought.

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Embalmers' Monthly
Engineering and Contracting
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Factory
Farm Implement News
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Fire and Water Engineering
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Furniture Manufacturer and Artisan
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Implement and Tractor Age
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Industrial Arts Magazine
Inland Printer
Iron Age
Iron Trade Review
Lumber
Lumber Trade Journal
Lumber World Review
Manufacturers' Record
Manufacturing Jeweler
Marine Engineering & Shipping Age
Marine Review
Millinery Trade Review
Mill Supplies
Mining and Scientific Press
Modern Hospital (The)
Motor Age
Motorcycle and Bicycle Illustrated
Motor Truck
Motor World
National Builder
National Cleaner & Dyer
National Laundry Journal
National Petroleum News
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Northwest Commercial Bulletin
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Power
Power Boating
Power Farming Dealer
Power Plant Engineering
Price Current—Grain Reporter
Printers' Ink
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Railway Electrical Engineer
Railway Maintenance Engineer
Railway Mechanical Engineer
Railway Signal Engineer
Retail Lumberman
Rock Products
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Textile World
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JESSE H. NEAL, Executive Secretary

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Underfeed Stoker Co. of America, Detroit, Mich.

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Lagonda Mfg. Co., Springfield, Ohio.
Plant Eng. & Equip. Co., Inc., New York.
Underfeed Stoker Co. of Amer., Detroit, Mich.

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Babcock & Wilcox Co., N. Y.
Badenhausen, Phillips, Phila.
Heine Boiler Co., St. Louis, Mo.
Power Specialty Co., New York.

TANKS.

Bowser & Co., Inc., S. F., Fort Wayne, Ind.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Heine Boiler Co., St. Louis, Mo.
Petroleum Iron Works Co., The, Sharon, Pa.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.
Sims Co., The, Erie, Pa.
Springfield Boiler Co., Springfield, Ill.
Wayne Oil Tank & Pump Co., Fort Wayne, Ind.

THERMOMETERS.

Ashton Valve Co., Boston, Mass.
Foxboro Co., Inc., The, Foxboro, Mass.
Hays Corp., The Jos. W., Michigan City, Ind.
National Regulator Co., Chicago.
Power Specialty Co., New York.
Thwing Instrument Co., Phila.

THERMOMETERS, RECORDING AND INDICATING.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Defender Auto Regulator Co., St. Louis, Mo.

TOOLS AND SUPPLIES.

Pilley Packing & Flue Brush Mfg. Co., St. Louis, Mo.
Pollard Co., Inc., Jos. G., Brooklyn, N. Y.
Strong Mach. & Supply Co., N. Y.
Williams & Co., J. H., New York.

TRAMWAYS.

American Steel & Wire Co., Chicago-New York.

TRANSMISSION ROPE.

American Steel & Wire Co., Chicago-New York.

TRAPS, VACUUM.

American Blower Co., Detroit.
Davis Regulator Co., G. M., Chicago, Ill.
Ellis Drier Co., The, Chicago.
Nashua Mach. Co., Inc., Nashua, N. H.
Sarco Company, Inc., New York.
Schutte & Koerting Co., Phila.

TUBE CUTTERS.

Lagonda Mfg. Co., Springfield, Ohio.
Liberty Mfg. Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

TUBING.

National Tube Co., Pittsburgh.
Scully Steel & Iron Co., Chicago.

UNDERGROUND HEATING SYSTEM

American Dist. Steam Co., Tonawanda, N. Y.
Johns-Manville, Inc., N. Y.
Ric-Wil Co., Cleveland, Ohio.

UNIONS.

Atlas Valve Co., Newark, N. J.
Dart Mfg. Co., E. M., Providence, R. I.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVE RESEATING MACHINES.

Leavitt Machine Co., Orange, Mass.

VALVES, AUTOMATIC CUT-OFF.

Lagonda Mfg. Co., Springfield, Ohio.

VALVES, AUTOMATIC STOP AND CHECK.

Davis Regulator Co., G. M., Chicago, Ill.
Jenkins Bros., New York.
Pratt & Cady Co., Inc., Hartford, Conn.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

VALVES, BALL.

Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, BLOW-OFF.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Eckenroth Valve & Mfg. Co., Philadelphia, Pa.
Elliott Company, Jeannette, Pa.
Hancock Inspirator Co., N. Y.
Jenkins Bros., New York, N. Y.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.
Yarnall-Waring Co., Phila., Pa.

VALVES, BY-PASS.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N.Y.
Mason Regulator Co., Boston.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm. Cincinnati, O.
Schiller, Jos. F., Philadelphia.
Scully Steel & Iron Co., Chicago.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES, CHECK.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Eynon-Evans Corp., Phila.
Hancock Inspirator Co., N. Y.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N.Y.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Pratt & Cady, Inc., Hartford, Conn.
Powell Co., Wm., Cincinnati, O.
Schutte & Koerting Co., Phila.
Strong Mach. & Supply Co., N. Y.

VALVE DISCS.

Belmont Packing & Rubber Co., Philadelphia, Pa.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N.Y.
N. Y. Belting & Pkg. Co., N. Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Sandusky Packless Valve Co., Sandusky, Ohio.
Strong Mach. & Supply Co., N. Y.

VALVES, FLOAT.

Atlas Valve Co., Newark, N. J.
Davis Regulator Co., G. M., Chicago, Ill.
Mason Regulator Co., Boston.

VALVES, GAS.

Pratt & Cady Co., Inc., Hartford, Conn.
Smith Gas Eng. Co., Dayton, O.

VALVES, GATE.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Eynon-Evans Corp., Phila.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N.Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Schutte & Koerting Co., Phila.

VALVES, GLOBE.

Crane Co., Chicago, Ill.
Eynon-Evans Corp., Phila.
Hancock Inspirator Co., N. Y.
Jenkins Bros., New York, N. Y.
Kennedy Valve Co., Elmira, N.Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Valve, Fdry. & Const. Co., Pittsburgh, Pa.
Powell Co., Wm., Cincinnati, O.
Sandusky Packless Valve Co., Sandusky, Ohio.
Schutte & Koerting Co., Phila.

VALVES, HYDRAULIC.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Crane Co., Chicago, Ill.
Kennedy Valve Co., Elmira, N.Y.
Pratt & Cady Co., Inc., Hartford, Conn.
Yarnall-Waring Co., Phila., Pa.

VALVES, NON-RETURN.

Ruggles-Klingemann Mfg. Co., Salem, Mass.

VALVES, PACKLESS.

Sandusky Packless Valve Co., Sandusky, Ohio.

VALVES, POP SAFETY.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Lunkenheimer Co., Cincinnati, O.

VALVES, PUMP.

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Jenkins Bros., New York, N. Y.
New York Belting & Packing Co., New York.
Quaker City Rubber Co., Phila.
Strong Mach. & Supply Co., N. Y.

VALVES, RADIATOR.

American Dist. Steam Co., Tonawanda, N. Y.
Jenkins Bros., New York, N. Y.
Powell Co., Wm., Cincinnati, O.
Pratt & Cady Co., Inc., Hartford, Conn.

VALVES, REDUCING.

Atlas Valve Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Elliott Company, Jeannette, Pa.
Mason Regulator Co., Boston.
National Regulator Co., Chicago.
Powers Regulator Co., Chicago.
Ruggles-Klingemann Mfg. Co., Salem, Mass.
Sarco Company, Inc., New York.
Squires Co., C. E., Cleveland, O.
Underfeed Stoker Co. of Amer., Detroit, Mich.
Watson & McDaniel Co., Phila.

VALVES, REGRINDING.

Eckenroth Valve & Mfg. Co., Philadelphia, Pa.
Mason Regulator Co., Boston.
Pratt & Cady Co., Inc., Hartford, Conn.

VALVES, REGULATING.

Atlas Valve Co., Newark, N. J.
Underfeed Stoker Co. of Amer., Detroit, Mich.

VALVES, RELIEF.

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Lonergan Co., J. E., Phila., Pa.
Mason Regulator Co., Boston.
Underfeed Stoker Co. of Amer., Detroit, Mich.

VALVES, RUBBER.

Belmont Packing & Rubber Co., Philadelphia, Pa.
Lonergan Co., J. E., Phila., Pa.
Metric Packing Co., Inc., Buffalo.
N. Y. Belting & Pkg. Co., N. Y.
Quaker City Rubber Co., Phila.

VALVES, SAFETY, NON-RETURN.

Lunkenheimer Co., Cincinnati, O.

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American Blower Co., Detroit.
Wing Mfg. Co., L. J., New York.

VISES, CHAIN PIPE.

Williams & Co., J. H., Brooklyn, N. Y.

WATER COLUMNS AND ALARMS.

Lunkenheimer Co., Cincinnati, O.
Reliance Gauge Column Co., Cleveland, Ohio.
Williams Gauge Co., The, Pittsburgh, Pa.

WATER METERS.

Bailey Meter Co., Cleveland.
H. S. B. W.-Cochrane Corp., Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Richardson Scale Co., Passaic, N. J.
Yarnall-Waring Co., Phila., Pa.

WATER PURIFYING APPARATUS.

Borromite Co. of Amer., Chicago.
International Filter Co., Chicago.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.

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Borromite Co. of Amer., Chicago.
Dearborn Chemical Co., Chicago.
International Filter Co., Chicago.
Permutit Co., The, New York.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.

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American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Lonergan Co., J. E., Phila., Pa.
Powell Co., Wm., Cincinnati, O.

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American Steel & Wire Co., Chicago-New York.

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American Steel & Wire Co., Chicago-New York.

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Strong, Carlisle & Hammond Co., Cleveland, O.
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Williams & Co., J. H., Brooklyn.

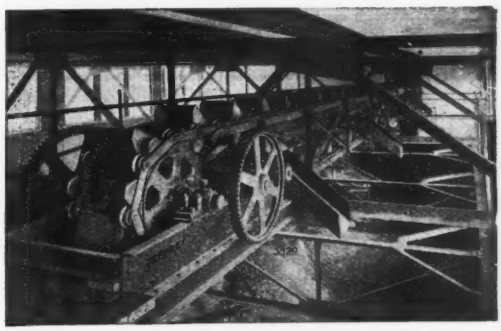
JEFFREY

Standardized V-Bucket Elevator Conveyer

ESPECIALLY designed for plants where the desired capacity for handling coal is less than 50 or 60 tons per hour, or where conditions do not permit of a vertical type elevator being extended so as to spout the material to points desired. It may be used either as a run-around Conveyor or as a Combined Elevator and Scraper.

It is adapted very simply to the handling of slack or stoker sized coal.

As an outgrowth of our many years of operating and field experience in installing Coal and Ashes Handling systems we can offer 20 standardized V-Bucket Elevator Conveyers to suit various requirements and conditions.



Upper run of V-Bucket Elevator-Conveyer showing Discharge Chutes to Bin Storage in a power plant

The Jeffrey Manufacturing Co.
905 North Fourth Street. Columbus, Ohio

Scranton	Cleveland	Dallas
Buffalo	Charleston, W.Va.	Milwaukee
Pittsburgh	Chicago	Denver
New York	St. Louis	Los Angeles
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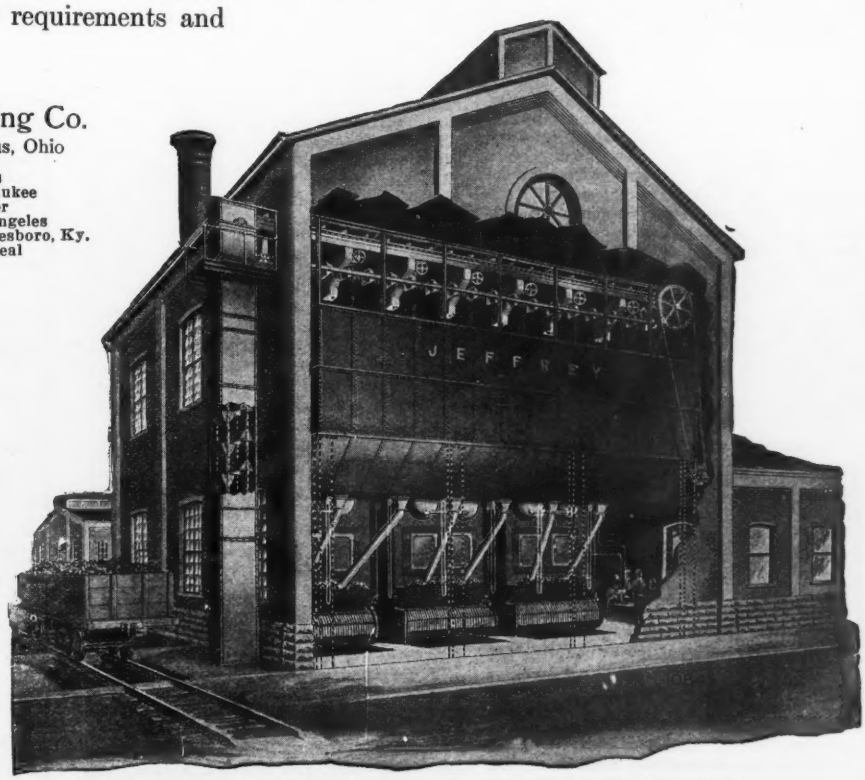
Jeffrey complete Coal and Ashes Handling Machinery. Equipments Include:

- Crushers
- Pulverizers
- Elevators
- Conveyers
- Weigh Hoppers
- Bins — Chutes
- Skip Hoists
- Electric Trolley and Storage Battery Locomotives
- Coal Loaders
- Car Unloaders



Coal being distributed to Bunkers in Boiler House by a Jeffrey V-Bucket Elevator-Conveyer

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Quick Action Opportunities

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Advertisements in the Signboard Section which come under the classification "Position Wanted," "Help Wanted," "Salesmen and Agencies," "Business Opportunities," "Patent and Patent Attorneys" and "Technical Books" will be set in type as shown below and published at the rate of

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2 in.	10.80	1 col. (8½ in.)	43.35
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Not less than one inch to be sold in these classifications.

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POSITION WANTED—Assistant Stationary Engineer, reliable, four years' experience; refrigeration plant preferred. Address Box 685, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

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SALES ENGINEER OR REPRESENTATIVE—One who is calling on power plants in Boston, Mass., and vicinity, Buffalo, N. Y., and vicinity to sell on commission as side line high grade article that is needed and wanted by every power plant. Address Box 688, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

SALESMAN—One who is calling on power plants in any part of Pennsylvania, New Jersey, Delaware, Maryland, to sell on commission as side line high grade article that is needed and wanted by every power plant. Address Box 680, Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill. tf.

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WANTED—High grade combustion engineer who has had experience and boiler room practice, capable of handling men, superintend installations of combustion system, analyze power plant troubles, etc. Must have best references. Address Box 689 Power Plant Engineering, 537 So. Dearborn St., Chicago, Ill.

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PATENTS AND PATENT ATTORNEYS

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A. P. CONNOR, Consulting Electrical and Mechanical Engineer. Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf

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Patents obtained and Trade-Marks registered in the United States and foreign countries. Patent practice exclusively in Patent Office and Courts. Examinations made and opinions rendered as to patentability of inventions, and validity, scope and infringement of patents. Highest references. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C.

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It is easy for an engineer to make from $5.00 to $10.00 a week extra by representing POWER PLANT ENGINEERING. One of our men, who makes big money, when asked why he chose this magazine to sell, said: "Having read POWER PLANT ENGINEERING for several years and being greatly helped by it, I saw the tremendous value it would be to every other power plant man. For that reason, I knew it would be a good seller, and your offer was so liberal that I decided to try it out. I am not sorry." You, too, can turn your spare time into money. We want additional representatives in every large city. You ought to average at least $1.00 an hour for your spare time. The work is interesting and the commissions total so large that some of our representatives make a very handsome extra salary. If you have a few hours weekly and if you can use the extra dollars, write for terms to

POWER PLANT ENGINEERING

537 So. Dearborn St., Chicago, Ill.

SIGNBOARD SECTION
Quick Action Opportunities

EQUIPMENT WANTED

WANTED

1—12 ton refrigerating machine. Steam driven. Complete high pressure side wanted. Also double pipe brine cooler. State type, and condition of machine and length of service. Address Box 677.

POWER PLANT ENGINEERING
537 So. Dearborn St. Chicago

WANTED

150 H.P. Bessemer Oil Engine in first class running order.

T. SHRIVER & COMPANY
Harrison, N. J.

EQUIPMENT FOR SALE

625 KV.A.—ENG. SET

G. E. Gen. 480-240 v. 60 cy. 3 ph. ALLIS "HEAVY DUTY" ENG. 22″x44″x42″.

An exceptional bargain

ROSS POWER EQUIPMENT CO.
Indianapolis, Ind.

Would YOU buy a SECOND-HAND ELECTRIC MOTOR at ANY price? you KNEW it to be as good as new? *Wire us your inquiries.*

GREGORY ELECTRIC CO. CHICAGO, ILLINOIS

Second-hand Electric Motors Bought, Sold and Exchanged. In business since 1893.

16th and Lincoln Streets Chicago, Ill.

Opportunities

What Are You Looking For ?

—a position
—a man to fill a vacancy
—a business representative
—a buyer for your used equipment
—good used equipment that is for sale

You'll find them in the **Signboard Section**

EQUIPMENT FOR SALE

Power Machinery Exchange

1 Montgomery St., Jersey City, N. J.

SPECIAL

250 K.V.A. Wghse. 3 or 2 Phase Alternator dir. con. Erie Ball 4 valve Corliss engine; two years' service.

A. C. 60-Cycle Units

Kw.	Generator	Engine
625	Wghse.	Parsons Turbine
600	G. E.	Rice-Sargeant Corliss
500	Wghse.	Parsons Turbine
500	Wghse.	Hamilton Corliss
475	G. E.	Skinner Uniflow
375	G. E.	Curtis Turbine
360	G. E.	Harris Corliss
300	Allis-Chal.	Skinner, 20 x 20
250	Allis-Chal.	Hamilton non-releasing
200	Wghse.	Ridgway
150	Wghse.	Rice-Sargeant Corliss
150	Allis-Chal.	Ideal Tandem
125	G. E.	Harrisburg
120	G. E.	Hamilton, 12 x 24
100	G. E.	Harrisburg
75	G. E.	Harrisburg
50	G. E.	Erie Ball
75	Allis-Chal.	Erie Ball
60	G. E., 3-wire	Skinner, Uniflow
50	Wghse.	Ideal
50	Wghse.,3-wire	Ames
40	G. E., 3-wire	Skinner, Uniflow
35	G. E., 3-wire	Harrisburg
25	G. E., 3-wire	Troy, vert.
25	Ridgway	Ridgway
10	G. E.	G. E. Marine

230-250-Volt D. C. Units

Kw.	Generator	Engine
300	G. E.	Watts-Campbell-Cor.
200	Wghse.	Erie Ball
100	Wghse.	Erie Ball
75	G. E.	Skinner

110-125-Volt D. C. Units

Kw.	Generator	Engine
300	G. E.	Fleming, 4-valve
200	G. E.	Fleming, 4-valve
100	Wghse.	Skinner
75	G. E.	Harrisburg
60	G. E.	Harrisburg
50	G. E.	Harrisburg
50	Wghse.	Skinner
30	G. E.	G. E. Marine
30	G. E.	Erie Ball
25	Wghse.	Erie Ball
20	G. E.	Harrisburg
15	G. E.	Marine, vertical
10	G. E.	G. E. Marine
7	G. E.	G. E. Marine
2½	G. E.	Engberg, Marine

Complete Stock of A. C. and D. C. Generators, Motors, also Corliss Engines, Etc.

Feed Water Heaters For Sale

Two "Cochrane" (1 new) horizontal, back pressure type, open feed water heaters, 20,000 H.P. each, with Weir box, valves, etc. Also complete system high pressure piping, valves, fittings, etc., for 12″ to 24″ pipe, 250 lbs. Water Pressure.

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FOR SALE

The Town of Burlington, Colorado, has a complete Semi-Diesel Oil Engine Electric Light Plant for sale, consisting of the following:

1—75 H.P. Fairbanks-Morse Type Y Oil Engine, Direct Connection to 2300 Volt, 62½ KV.A. Generator.
1—50 H.P. Fairbanks-Morse Type Y Oil Engine, Belt Connected to 37½ KV.A. Generator.

Plant is complete with starting apparatus switchboard, 12,000 gallon fuel oil storage tank and so forth. Plant has been in service four years. Machinery is in good condition.

WRITE

J. M. HEFNER, City Clerk,
Burlington, Colorado

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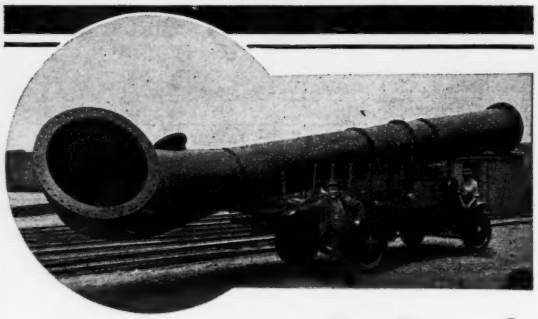

—For Example

The Exhaust Riser Shown Above

which was 34 ft. 6 in. in length, consisting of 5—6 ft. lengths, 3 ft. in diameter, welded together as shown and to the 4-ft. diameter increasing elbow made of 6 sections with a 14-in. outlet with the Square Lap Flange.

As Piping Fabricators and Contractors we can handle your entire installation from the time you conceive it until it becomes a finished M. J. D. product. Or we can co-operate with your engineers, fabricating and erecting the piping according to your plans, or we will furnish materials only.

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Write for Bulletin E-12

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If you have something to sell you don't go into a secluded corner and whisper the news.

You will go where the people are and state your proposition. You won't whisper, either. You want attention!

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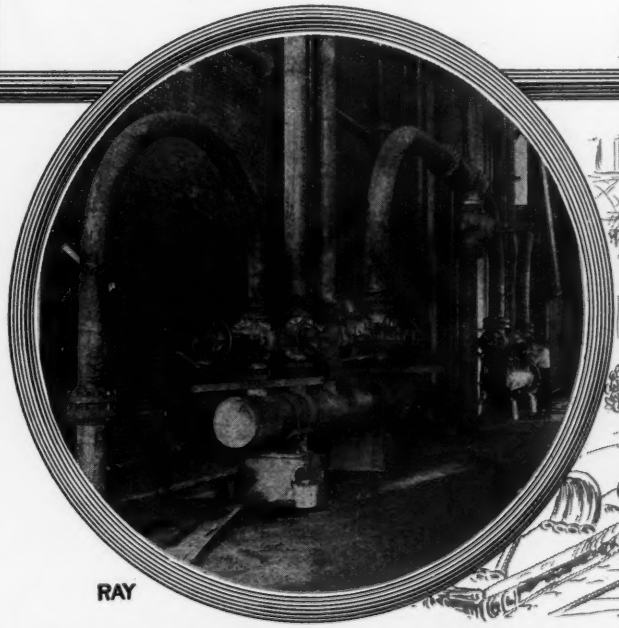

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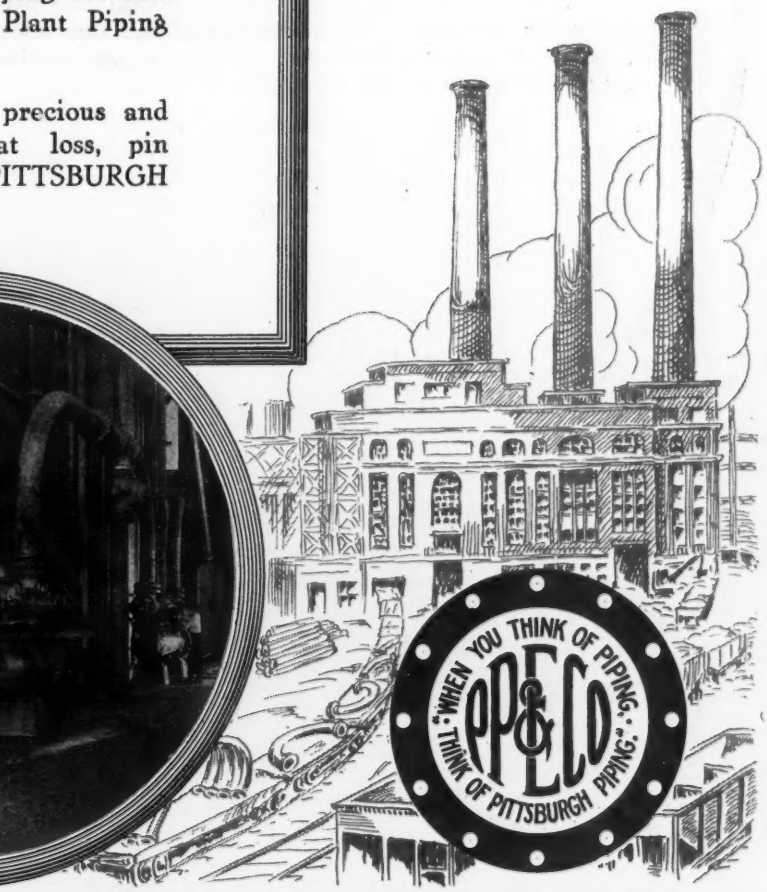

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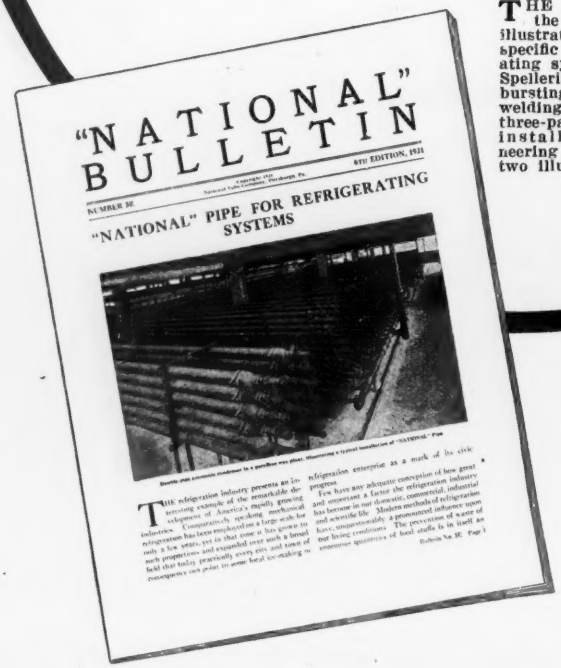
A new "NATIONAL" Bulletin for Power Plant and Refrigeration men

REFRIGERATION ENGINEERS will find this revised edition of "NATIONAL" Bulletin No. 5 full of helpful information; the text has been completely rewritten and some new material has been added in the shape of technical and mechanical information and illustrations—making the Bulletin a practical text book from certain viewpoints.

The layman as well as the engineer will find this Bulletin informative and interesting; all of it has been written in a non-technical manner with the exception of a section devoted to tabular matter, formulae, etc., relating to refrigerating practice and to the tubular materials used in refrigeration installations.

THE contents include an explanatory outline of the Compression, Absorption, and Brine Systems, illustrated with line diagrams; a section on the specific advantages of "NATIONAL" Pipe for refrigerating systems, embracing chapters on such subjects as Spellerizing, welding-scale free pipe, physical properties, bursting-strength, correct pipe threading principles, welding qualities and durability of pipe in service; a three-page description of a modern refrigeration installation; the tabular matter and other engineering information previously mentioned; and forty-two illustrations from photographs and line drawings.


"NATIONAL" BULLETIN

8TH EDITION, 1921

NUMBER 5

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The Delaware Power Station of the Philadelphia Electric Company, which furnishes light and power to the great city of Philadelphia, is one of the largest power plants ever constructed of reinforced concrete.

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The experienced engineers responsible for such big installations know how largely the permanency of the piping system figures into the profitable operation of the plant. They specify Reading Open Hearth Steel Flanges and Fittings to make the points of greatest strain the strongest and most durable.

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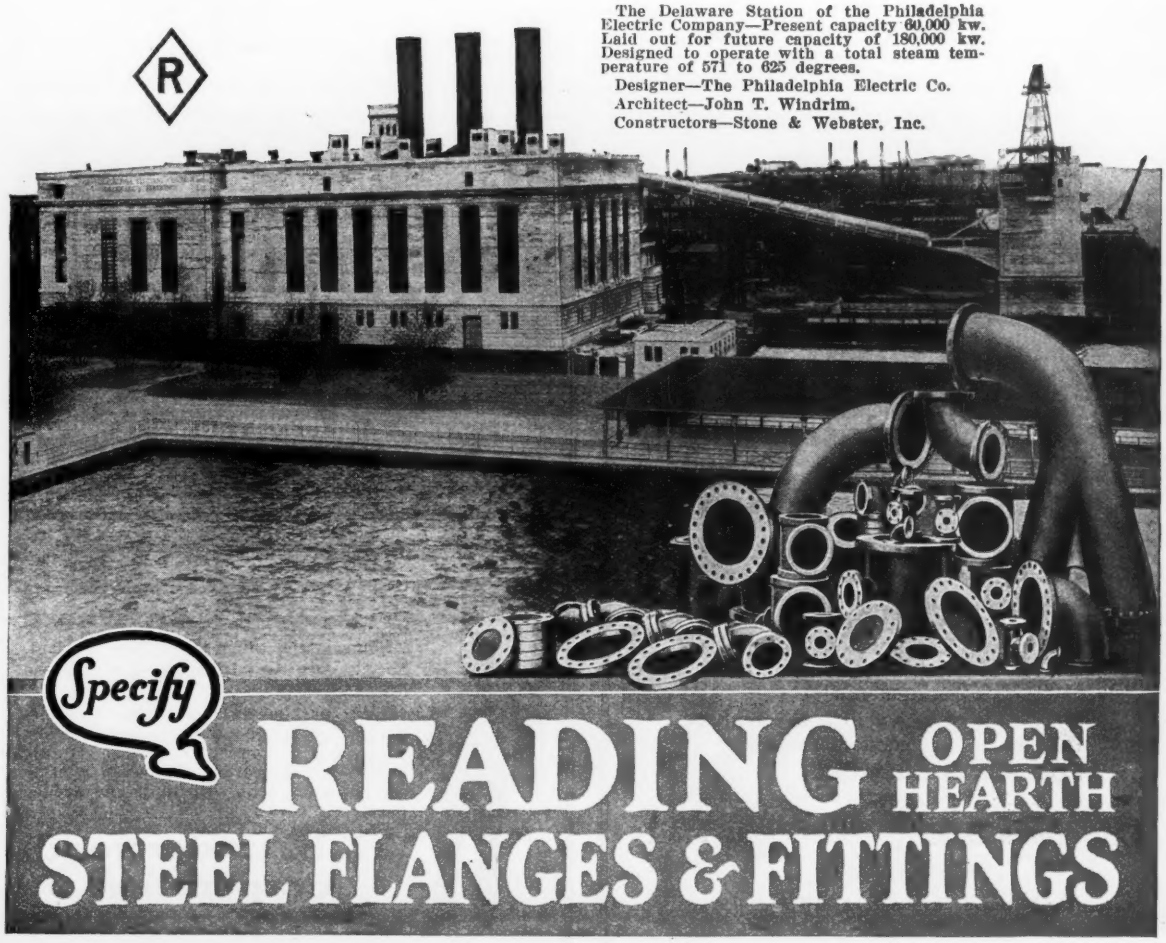

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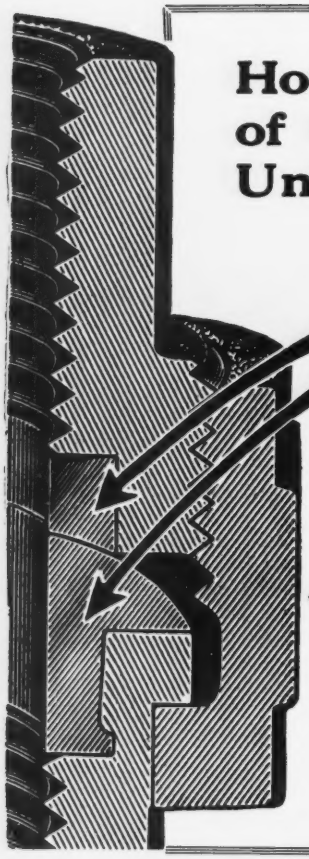

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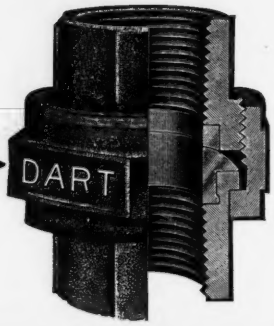

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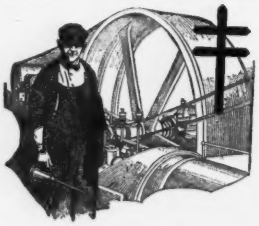

Keep the Man Going Who Keeps Industry Going

What oil is to the machine, health is to the worker. The efficiency of both is essential to good business.

An average of 2½ years of productivity would be added to the life of every individual who reaches the age of 17, if there were no fatal cases of tuberculosis. The economic loss to America due to tuberculosis is more than $500,000,000 annually.

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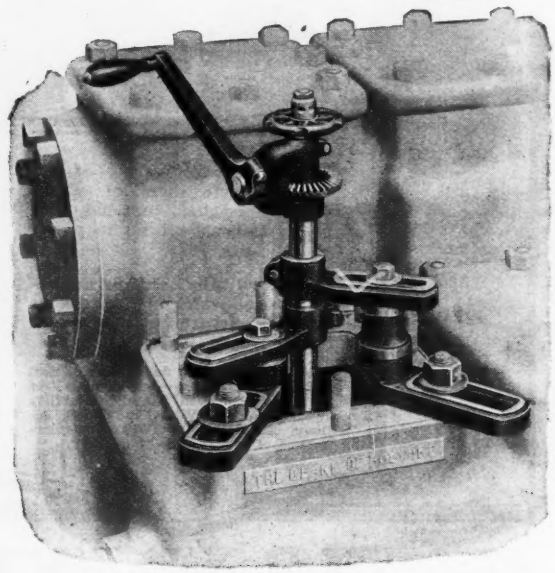

to remove and reface your pump valves?

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refaces them while they are in the deck. It is not necessary to remove them. They can be refaced in half the time it requires to take them out.

This can be done 10 to 20 times.

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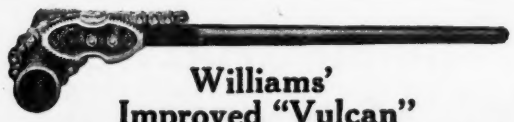

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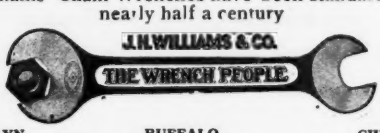
With *Proof-Tested* Chain

8 Sizes for ⅛ to 18-in. Pipe

Williams' Chain Wrenches have been standard for nearly half a century



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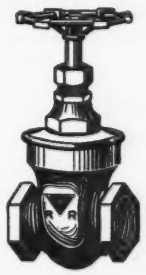

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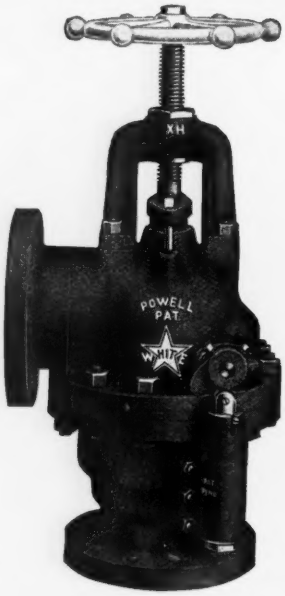

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Cast Steel for Superheated Steam.
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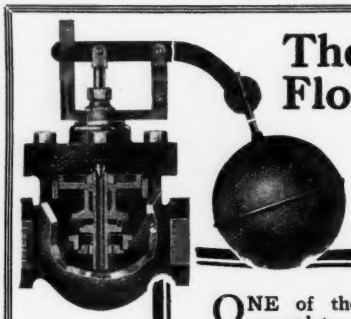

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It automatically controls the admission of water into a tank or reservoir according to rise and fall of water level.

The 72-page catalog describes in detail all Davis equipment—valve specialties that are renowned for dependability and long life. Write to the G. M. Davis Regulator Co., 429 Milwaukee Avenue, Chicago, for your copy.

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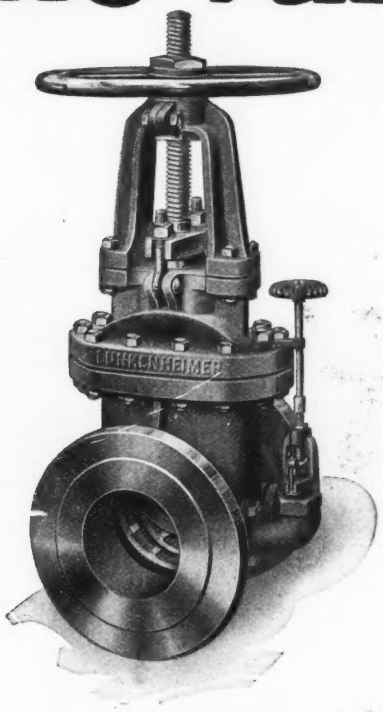
LUNKENHEIMER "Victor" Gate Valves



Dependable performance is the service record of LUNKENHEIMER "VICTOR" Gate Valves. The "VICTOR" solid wedge disc, double-faced and guided in its travel, is the most practical design of Gate Valve construction. It eliminates "dragging" across the seat ring faces and the consequent wear prevalent in valves employing loose parts.

Highest quality materials, coupled with the LUNKENHEIMER method of manufacture: bearings bronze bushed to minimize wear: the indestructible gasket between the bonnet and body flanges and all parts, including the seat rings renewable: all tend to enhance their value and insure longevity.

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"VICTOR" Gate Valves are also made in Bronze for pressures up to 250 pounds, and in Cast Steel for pressures up to 350 pounds and temperatures to 800° F.

Specify LUNKENHEIMER "VICTOR" GATE VALVES and insist on their installation.

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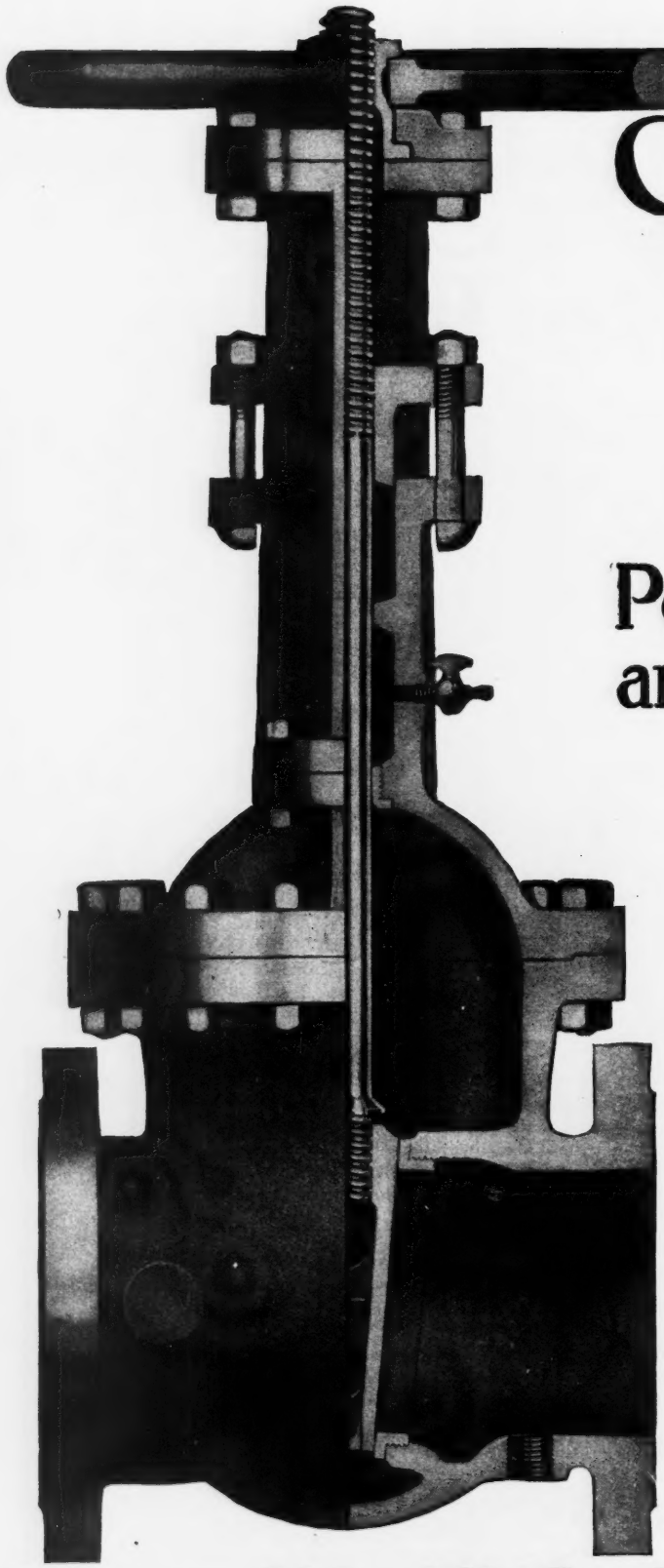

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Performance and Reputation Count

On the Chapman List 63½—Steel Valves for Superheated Steam—just what does it mean?

Of course, it is, first of all, a Real Guarantee covering any and all defects of workmanship or material that may develop within five years of the date of installation.

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It is a Super-Valve for Superheated Steam.

Ask for the Chapman Valve Handbook No. 38.

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Chapman Valve Mfg. Co. ~ Indian Orchard Mass

Making Good the Guarantee

Williams Double-Disc Gate Valve No. 127—the "Dreadnaught" among Valves—in pipe line. Ask your dealer for it.

No effort to shirk responsibility! No grumbling over severity of the service demanded! No "ifs or ands" or quibbling of any nature!

Service at a profit! That is the plainly understood proposition on which all **Williams Valves** are sold. Discriminating valve buyers know the **Williams** saves coal, labor, time and trouble, and assures uninterrupted production. Profits from such service are incalculable.

Williams Double-Disc Gate Valve No. 127

"A Dreadnaught in Service"

is one of the peerless **Williams** line that is famed for abolishment of all waste—for the insurance of a full, steady and leakless flow of Air, Steam, Water, Gas or Oil.

A tight seat is assured by the ball and socket bearing discs that also compensate for any temperature distortion or sagging of pipe lines.

An **exclusive** Williams feature is the Union Ring method of securing the bonnet to the body, providing a rigid, steam-tight joint that cannot corrode.

The heaviest stem used in any gate valve—made of special hard bronze that will not bend or break. Acme Standard threads assure maximum wear and long life. Packing is forced against the stem by a Packing Gland Follower.

Many other features that explain the extremely satisfactory service of Williams Valves are described in our Catalogue 10. It clearly explains why Williams Double-Disc Gate Valve No. 127 always makes good.

Made in two patterns—Medium for 200 lbs. pressure and Extra Heavy for 350 lbs. pressure. **Satisfaction Guaranteed.**

Catalogue No. 10 mailed promptly on request.

Dealers Carry Williams Valves and Will Fill Your Order for a Sample Promptly.

The D. T. Williams Valve Company

Cincinnati, Ohio

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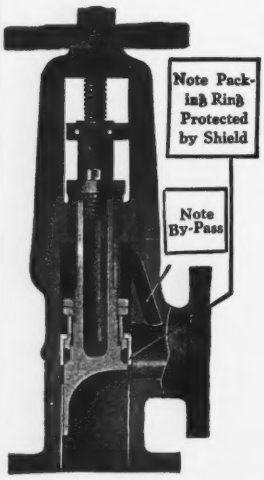

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The heavier the boiler pressure the tighter becomes the packing ring on Schiller Blow-Off Valve.

All boiler pressure comes on the shield, which expands the packing ring.

Water circulation on both sides of valve gives a **perfect balance.** Full and unrestricted opening. No seat to be cut by scale or sediment. Packing ring protected at all times.

Balanced—Seatless—Automatic
Schiller Blow-off Valves

are of extra heavy type, easily operated and extremely durable in service. Guaranteed at 300 lbs. pressure. Made in angle or straightway types—iron, bronze or steel bodies. Working parts of the best bronze, interchangeable, and piston one piece phosphor bronze.

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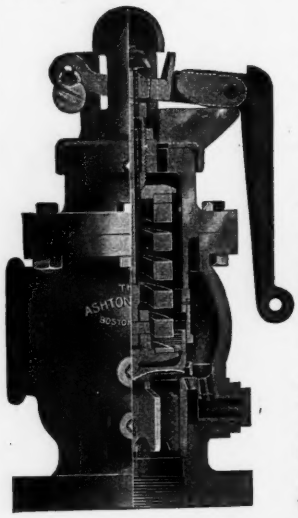
Ashton-ize Your Boilers

and render them immune from disaster due to excessive steam pressure, as well as to effect decided fuel economies.

Ashton Pop Safety Valves



never permit more than a sufficient amount of steam to be blown off in order to afford boiler relief.

You can lock the ASHTON after adjustment so that no one can tamper with the setting. It is automatic and efficient in its action, and enduring qualities are assured by the rigid tests to which each ASHTON is subjected before being sent forth for service.

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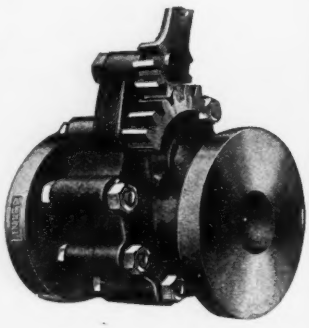
Guaranteed in Boiler Blow-off Service—
The EVERLASTING VALVE

is guaranteed to stay drop tight for two years. If it does not make good in your plant we will refund your money or replace the valve with a new one.

There is no stuffing box—it requires no packing — straight through blow — rotating disc — self-cleaning and self-grinding.

Made in sizes from ¼" to 16"—Screwed or Flanged Ends.

Booklet describes them in detail. Send for a copy today.



Scully Steel and Iron Co.

P. O. Box 814 Chicago, Illinois

Nineteen Years of Success
STRONG'S RIVALATE

The Great Silver Thread Metallic Packing has been making good since 1902, in the largest corporation plants of the world.

Illustration No. I—Used for sixteen years by the great plants of the U. S. Steel Corporation, on outside packed plunger pumps, stop and throttle valves, etc.

Send for a five or a ten-pound can. If not found exactly as represented send it back and get your money back.

The Strong Machinery & Supply Co.

Dept. A, 292 Church St., New York City

A Superior Valve
The ECKENROTH
Automatic Reseating Valve

It repairs itself by automatically reseating during the operation of closing. Natural wear across the surfaces is compensated for by a slight wear around the seating surfaces.

Unequalled for boiler blow-off, steam and alkali service.

Write for Catalog.

Wears in where others wear out.

Eckenroth Valve & Mfg. Co.

158 Conarroe St., Manayunk, Phila., Pa.

Patented

More Than Nine Years' Service —*Not One Cent for Repairs*

THE two Yarway Seatless Blow-Off Valves shown below are in the plant of the Riverside Highland Water Company, Colton, Cal.

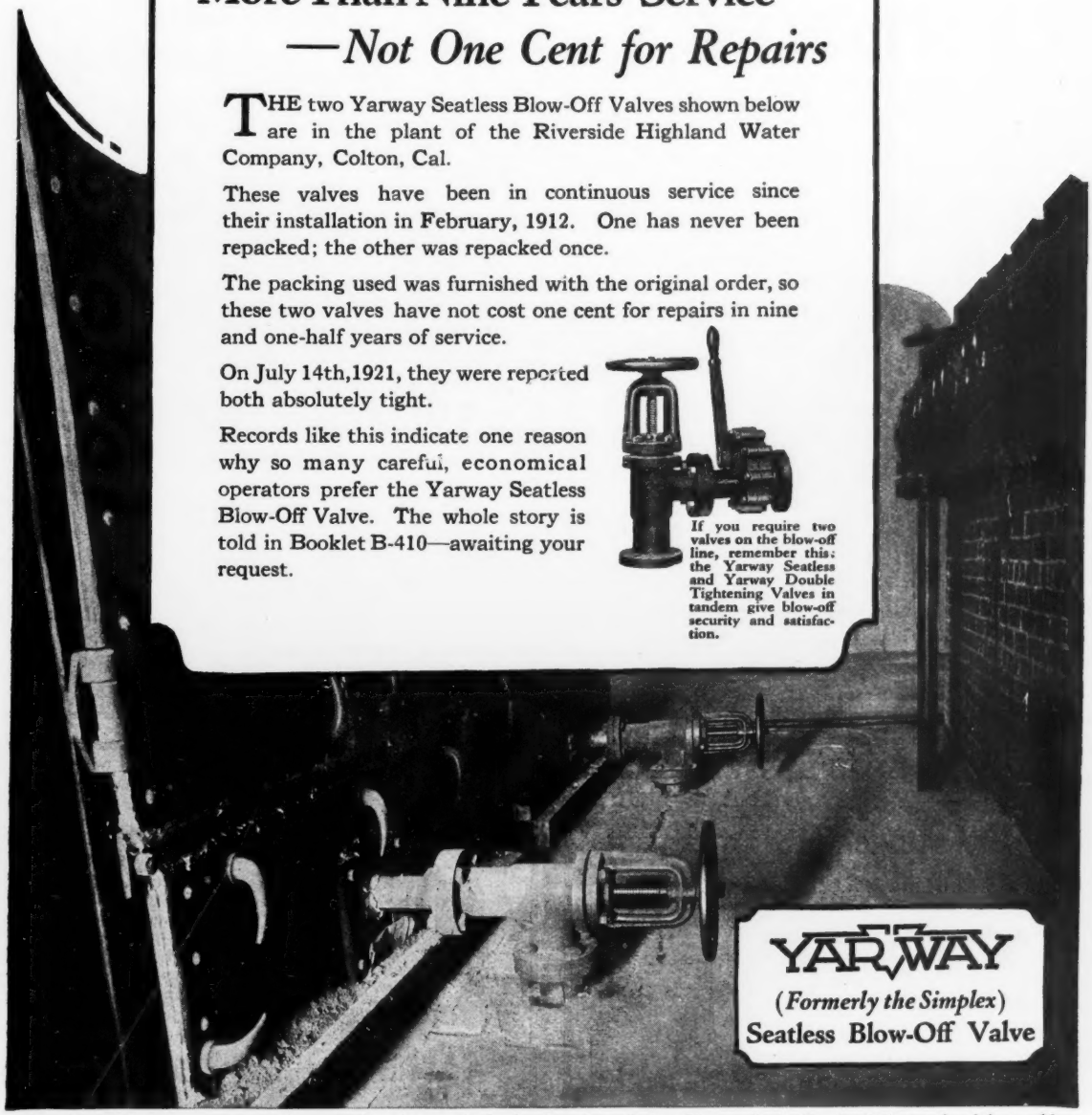
These valves have been in continuous service since their installation in February, 1912. One has never been repacked; the other was repacked once.

The packing used was furnished with the original order, so these two valves have not cost one cent for repairs in nine and one-half years of service.

On July 14th, 1921, they were reported both absolutely tight.

Records like this indicate one reason why so many careful, economical operators prefer the Yarway Seatless Blow-Off Valve. The whole story is told in Booklet B-410—awaiting your request.

If you require two valves on the blow-off line, remember this: the Yarway Seatless and Yarway Double Tightening Valves in tandem give blow-off security and satisfaction.



YARWAY
(*Formerly the Simplex*)
Seatless Blow-Off Valve

If you have leaky valves on water columns, turbine drips, and other hard service, substitute Yarway Junior Seatless Valves and end the trouble.

·YARNALL·WARING·COMPANY·

Penna. R. R. and Mermaid Lane

Chestnut Hill··Philadelphia

Representatives in all Principal Cities

For Complete List of Offices see Sweet's Engineering Catalog-Keystone Mining Catalog or Chemical Catalog

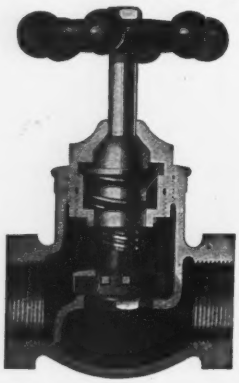
YARWAY SEATLESS BLOW-OFF VALVE··YARWAY DOUBLE TIGHTENING BLOW-OFF VALVE··YARWAY BOILER SKIMMER··YARWAY ADJUSTABLE SPRAY HEAD··YARWAY HYDRAULIC VALVE··YARWAY UNLOADER YARWAY-LEA V-NOTCH METER·· ·YARWAY· ··YARWAY PIPE CLAMPS·ETC.

POWER PLANT DEVICES

YOU Need the Service

SANDUSKY

PACKLESS VALVES Give



Because they —are leakless
—require no packing
—eliminate the expense of repairing, and renewing leaky valve stems.
—have no complicated parts
—have no contracted area
—save time, money and trouble.

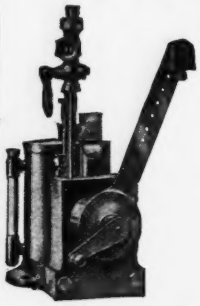
The Sandusky Packless Valve Company

1209 W. Adams Street,
Sandusky, Ohio.

New York Distributor:
Advance Engineering Co.,
168 Washington St., N. Y.

Try some at our expense for 90 days where service is the most severe. If they do not prove satisfactory, will refund your money.

ROCHESTER



Automatic Lubricators

For use on all types of steam engines and pumps and air and ammonia compressors.

Send for literature.

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SOLE MANUFACTURERS
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Cling-Surface

The Belt Preservative

See our full-page advertisement in every first of the month issue of this publication

Cling-Surface Co.
1028 Niagara St.,
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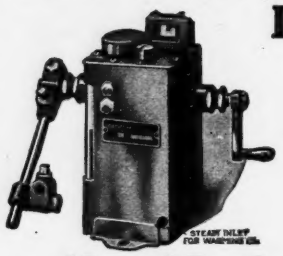
Airspring **COMPRESSED AIR GREASE CUPS**

Make Good Under the Hardest Tests

On locomotives, steamboats, marine engines, stationary and mill machinery, they have proved our claim, and they will also in your own plant. Try them at our risk for 60 days. No obligation on your part. Write for booklet.

Hunter Pressed Steel Company
450 Pierce Street, Lansdale, Pa.

The Manzel Oil Pump Is Positive



It supplies oil to the engine cylinder just as it is needed—never too much—never too little. It's always on the job, saving oil and saving the engine.

Ask for catalog

Manzel Brothers Company
327 Babcock St. Buffalo, N. Y.

30 Days' Free Trial

On Guard!

No more dry cylinders due to neglect when you guard your cylinders with a

Practical Sight-Feed Oil Pump

The operator is not troubled by blowing or draining it out. Oil poured into the bowl is all that is needed. It tends to itself, feeds any grade of oil regardless of temperature, regularly and positively against any pressure and in proportion to the operating speed. Learn more about this friend of the engineer. Send for catalogue "P."

McCullough Manufacturing Co.
Minneapolis, Minn.
Sold and Guaranteed by Leading Supply Houses.

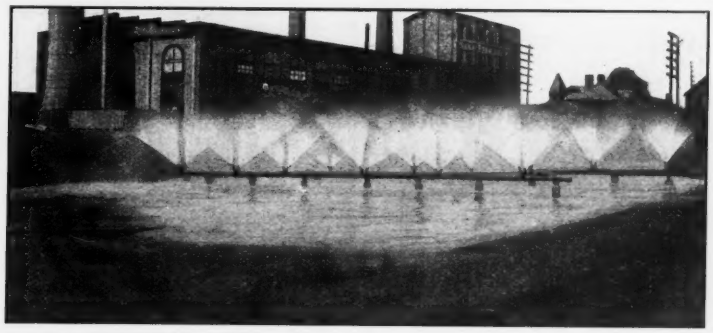
Positive Oil Flow
at any point in the delivery line is indicated by the "Blinker" sight feed of the

HILLS-McCANNA Force Feed Oil Pump

Simple and sturdy in design, with all working parts outside the oil reservoir, instantly accessible. Hills-McCanna force feed lubricators are a dependable and practical asset in handling your lubricating problems. Write today for new catalog.

HILLS-McCANNA CO. 2025 Elston Ave. CHICAGO

Koerting Multi Spray Nozzles



Will deliver cool water to condenser. Complete atomizing of water produces high cooling efficiency. Catalog 6-B.

KOERTING

PHILADELPHIA·PA·1156 THOMPSON ST·

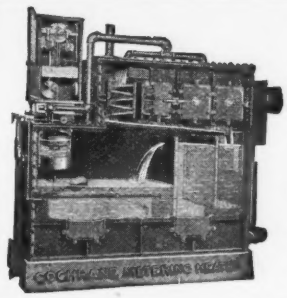
SCHUTTE

Increase Vacuum in Your Condensers with **SPRACO**

Cooling Ponds

Write for catalog C-42

Spray Engineering Company
Boston, Mass.



The Utilization of Exhaust Steam

offers one of the greatest economies possible in steam plants. Sometimes 50% of the fuel can be saved in this manner.

Our Engineering department would be glad to confer with you regarding possible ways of increasing economy and saving fuel in your plant.

H. S. B. W.-Cochrane Corporation

Formerly Harrison Safety Boiler Works

3144 North 17th Street Philadelphia, Pa.

Ross

Surface Barometric and Jet Condensing Equipments for Power Plants.
Main, Auxiliary, Distilling Condensers and Evaporators for Marine Service.
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Ross Boiler Feed Water Heaters.
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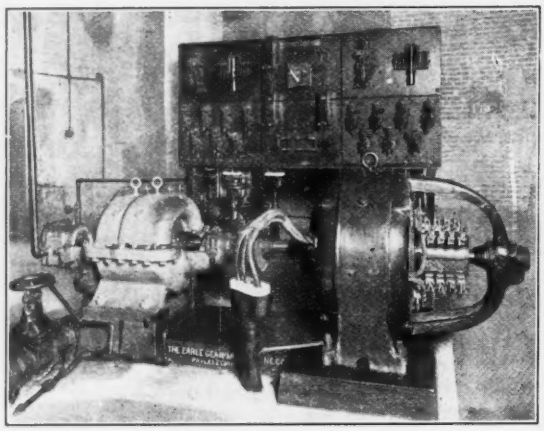
THE BRAND THAT LEADING ENGINEERS DEMAND

EARLE CENTRIFUGAL PUMPS

FOR SERVICE WHERE QUALITY COUNTS



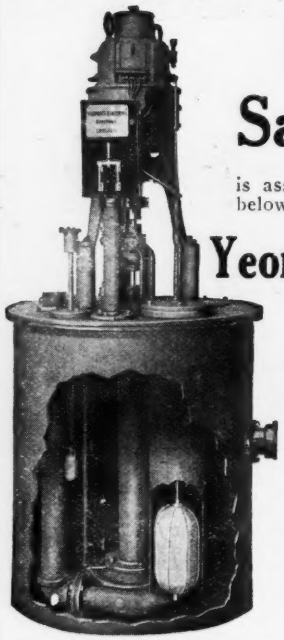
4-in., 3-stage EARLE Elevator Pump. One of three in an office building.

Send for the Booklet

We also manufacture Cut Gears, Special Machinery, Bridge Operating Machinery and "Lea-Simplex" Cold Metal Saws.

The Earle Gear & Machine Co.

4715 STENTON AVE., PHILADELPHIA, U.S.A.



Perfect Sanitation

is assured in sub-basements or below sewer levels if—

Yeomans Electric Bilge Pump

is installed. It is suspended in the catch basin from the basin cover and is operated by an electric motor mounted on the cover. A copper float, suspended in basin and connected to a switch automatically controls motor operation. When basin contents rise above a certain level the float rises and the motor starts. When basin contents fall below a certain level the float falls with them and closes the motor switch. Special devices assure perfect lubrication and prevent shaft corrosion.

Bulletin No. B-3100 describes fully. Write for it.

Yeomans Bros. Company

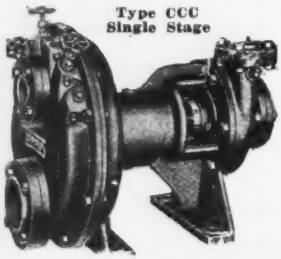
1432 Dayton Street **Chicago, Ill.**

Agents in Principal Cities

REGISTERED COPPUS U.S. PAT. OFFICE

Centrifugal Turbo Boiler Feed Pumps

Type CCC Single Stage

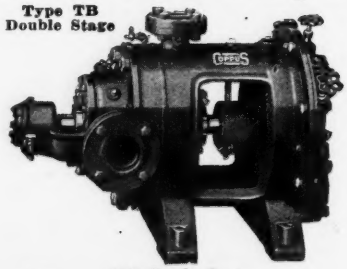


protect the pipe lines, joints and settings by providing to the boilers a steady, even and continuous flow of feed water, with no vibrations or pulsations. Peak load demands are met by a smooth but increased flow.

Only one moving element. Practically no attention required in service.

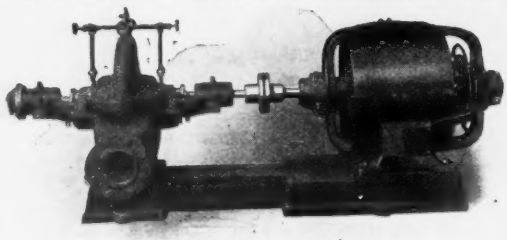
Bulletins describe both Type CCC and TB. Write for copy today.

Type TB Double Stage



Coppus Engineering & Equipment Co. **340 Park Ave. Worcester, Mass.**

TABER PUMPS Centrifugal, Rotary



Designed and built by pump specialists of 40 years' standing. Splendid workmanship. Very high efficiency. Write for the bulletins.

Taber Pump Co., 298 Elm St., Buffalo, N. Y.

MANISTEE "ROTURBO"

CENTRIFUGAL PUMPS

ROTARY JET CONDENSERS

Manistee Iron Works Co., Manistee, Mich.

GARDNER

Pumps-Governors-Compressors

What Does Your Money Buy?

The chief thing to consider is not the *mere* machine — *but rather the service the machine will give.* What you really buy is years of faithful service.

If a Gardner Pump gives you ten years of work, without fussing or fixing, while some other make wears out in half that time, the Gardner is worth twice as much as the other. And ten years of service, without any repairs worth mentioning, is not an unusual performance for Gardner Pumps, Governors and Compressors.

Let This Mark
Govern
Your Purchases

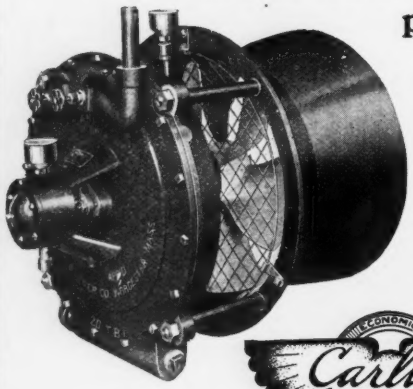
Have you the latest Gardner Bulletins on Pumps, Governors and Compressors? They will go to you on request.

THE GARDNER GOVERNOR COMPANY
Quincy, Illinois

Pumps—Governors—Compressors

Chicago	New York	Philadelphia	San Francisco	Los Angeles
Fisher Bldg.	Singer Bldg.	604 Arch St.	505 Howard St.	409 E. Third St.

Increases Steam Output from 100 to 200 per cent



Even with the cheapest grades of fuel peak load demands are met instantaneously with

ECONOMIC Carling BLOWERS SUPERIOR

Turbine Blowers

exhaust to ash pit, or to heater. Will carry back pressure up to 10 lbs.

They produce quick returns on the investment for the first cost is small, installation easy and operating expense low.

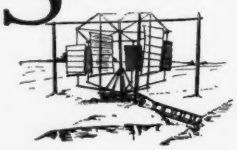
Write for details.

CARLING TURBINE BLOWER CO.

Engineers and Manufacturers, Worcester, Mass.

PUMPS

An early pumping device—the Chinese Windmill.



The ancient Chinaman didn't believe in doing anything that he could get natural forces to do for him. Witness this Windmill—for pumping salt water. The wind drives the mill, the mill drives the pump, and the sun does the rest, by drying out the salt. In this way, the Chinese "manufactured" great quantities of salt in a very cheap way.

American-Marsh Pumps are economical—in a modern, scientific manner. They have no unnecessary parts—no internal stuffing boxes, no tappets, no slide valves. Write for Bulletins.

American Steam Pump Co.

Battle Creek, Mich.

New York Office
17 Battery Place

Chicago Office
1220 Monadnock Block

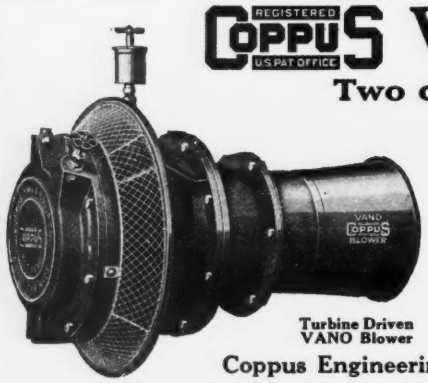
The American-Marsh line also includes Centrifugal Pumps, Power Pumps, Air Compressors, Vacuum Pumps, Condensers, Deep Well Engines.

Boiler Feed Pump

REGISTERED COPPUS U.S. PAT. OFFICE

VANO BLOWERS

Two of a Kind for Efficiency



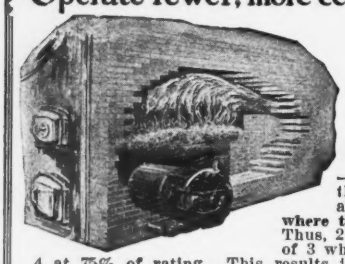
Turbine Driven VANO Blower

COPPUS VANO BLOWER "IT'S ALL IN THE VANES"

Motor Driven VANO Blower

Coppus Engineering & Equipment Co., 340 Park Ave., Worcester, Mass.

Operate fewer, more economical boilers-



with the

Wing

Turbine Blower

The Original-The Standard

—which makes possible the operating of boilers at about 150% of rating **where they are most economical.** Thus, 2 boilers will do the work of 3 which operate at rating, or 4 at 75% of rating. This results in boilers in reserve and savings of as high as 23%.

The Wing Blower Book is full of money-saving suggestions! Have you a copy?

L. J. Wing Mfg. Co. 659-669 Hudson Street, NEW YORK
Offices in Principal Cities.

Draft in Steady Abundance

may be implicitly relied upon if supplied by

"Sirocco" Fans

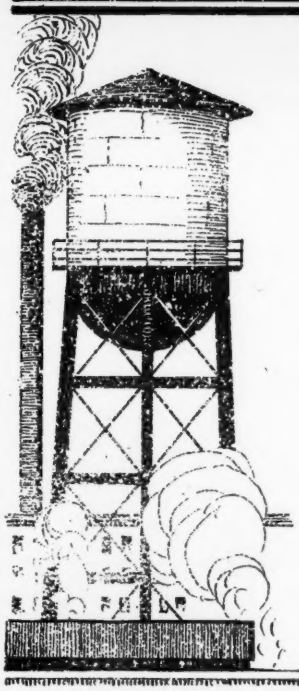
TRADE MARK.

High commercial efficiency. For heating, ventilating, drying, cooling and mechanical draft. Durable. Occupy minimum space—require minimum power in operation.

Write for Fan and Blower Catalogue.

American Blower Company, Detroit, Mich.

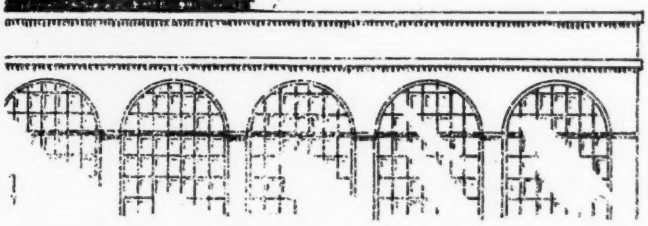
Branches in all large cities

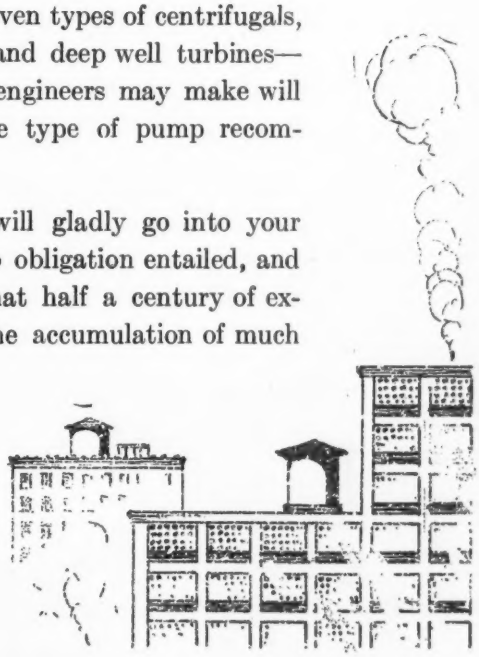


Feeding Water to the Big Plants

As manufacturers of proven types of centrifugals, deep well plunger pumps and deep well turbines—any recommendations our engineers may make will be without bias as to the type of pump recommended.

"American" engineers will gladly go into your pumping costs—there is no obligation entailed, and it is only to be expected that half a century of experience has resulted in the accumulation of much valuable data.





THE AMERICAN WELL WORKS

General Office and Works
AURORA, ILL.

Chicago Office
FIRST NATIONAL BANK BLDG.

NORWALK AIR & GAS COMPRESSORS

Every compression requirement is important enough to be handled on a basis of assured reliability and economy. That assurance goes with the Norwalk name.

Illustrated Bulletins on Request

The Norwalk Iron Works Co.

Pioneer Builders of Compressors

South Norwalk - Connecticut

It's the same old wish,
Very old 'tis true,
But this same old wish
We extend to you—

A Merry Christmas

Patterson-Kelley Co.

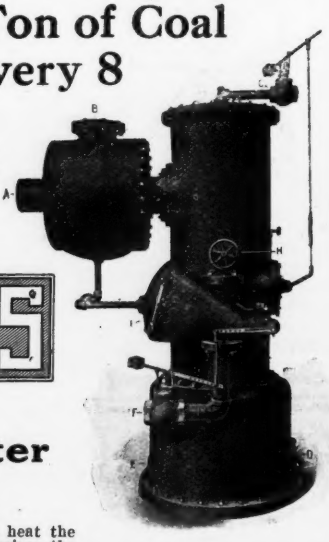
Water Heating Engineers
Manufacturers of Heaters

24 Cortlandt Street

New York City

Saves 1 Ton of Coal Out of Every 8

That's a saving of 12½ per cent—an economy of fuel large enough to interest any power plant. Any plant can do it, easily. Install a



SIMS

Open Feed Water Heater

and make your exhaust heat the boiler feed. The Sims raises the temperature of boiler water to 210 degrees—adds 140 to an initial temperature of 70 degrees; 140 degrees saves 12½ per cent of coal in the boiler room.

The Sims also precipitates all scale-forming material before the water enters the boiler. That saves tube cleaning expense, shutdowns, increases boiler capacity and adds to boiler life.

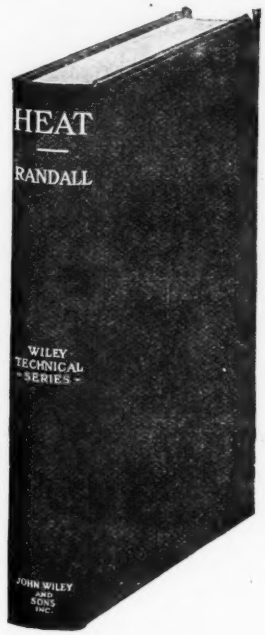
Write for literature describing both the Open and Closed Heaters and Oil Filters

The Sims Company

2001 Holland Street Erie, Pa.

"We keep others in hot water"

This is No. 10 of a series showing how recognized power plant authorities agree as to the value of feed water heating and explaining the particular advantages of Webster Heaters.



Randall Says:

"A boiler shell should not be subjected to sudden changes of temperature, either locally or as a whole. The resulting contraction produces serious strains, cracks, and sometimes explosions. Therefore, some means of supplying a boiler with water at approximately boiler temperature is a very important consideration." (page 159)

and *Webster*

Feed-water Heaters prove it

The experience of the thousands of users of Webster Feed-water Heaters shows that not only does a Webster Feed-water Heater improve the overall plant efficiency, thereby reducing fuel costs, but also saves wear and tear on the boilers, thereby reducing maintenance costs as well.

In the first place, as Randall states, strains due to unequal expansion are avoided when hot feed water is delivered to the boilers. Then, too, the highly efficient Webster Oil Separator and Filter assure a feed water free from oil and other impurities, thereby maintaining high boiler efficiency, avoiding the necessity of frequent cleaning of heat-transmitting surfaces and preventing a real danger.

Ask us to send you Bulletins describing the Webster Feed-water Heater and giving actual figures of results obtained in typical cases.

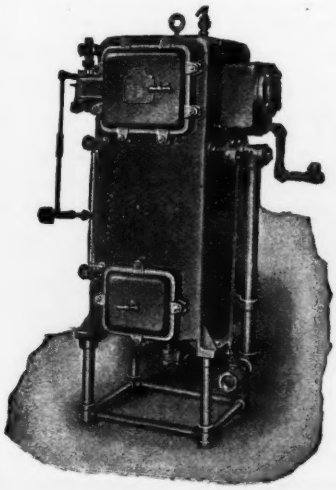
108

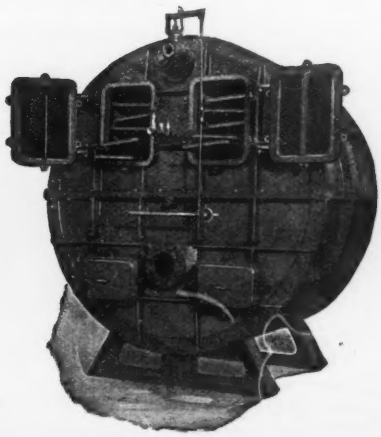
Warren Webster & Company

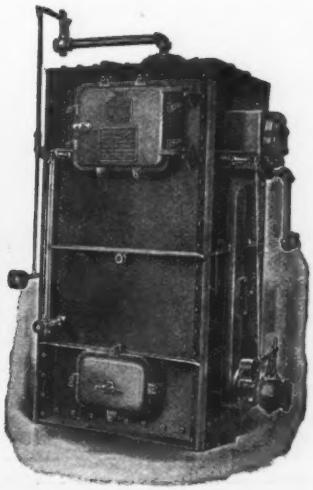
Main Office and Works: Camden, N. J.

Branch Offices in 31 Cities

There's a WEBSTER Feed-water Heater for every type of plant

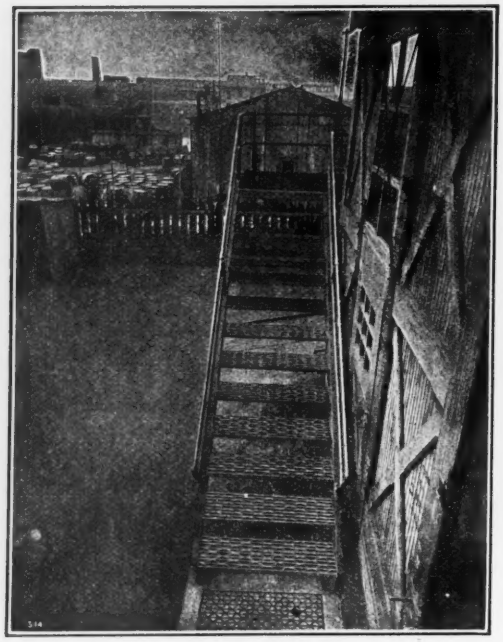






IRVING SUBWAY (PATENTED) TRADE MARK THE FIREPROOF VENTILATING FLOORING

IRVING SAFSTEP TRADE MARK (PATENTED)
ABSOLUTELY NON-SLIPPING ALWAYS



Safe—All the Time

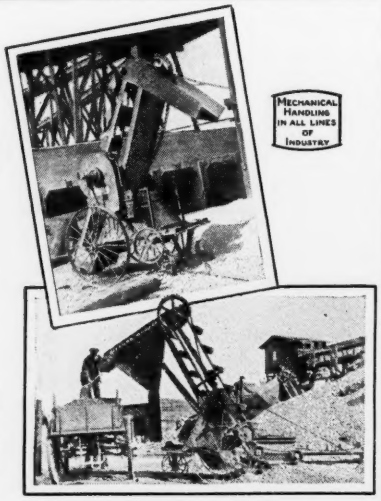
The non-slipping feature of the **Irving Safstep** is an inbuilt quality permanently inherent in the structure and therefore continuing throughout the life of the step. It is not secured by special treads or abrasive insets—time and wear do not affect it. Indoors, with oil or grease or soap upon it—outdoors, with water, snow or ice upon it—the **Safstep** is always a safe, non-slipping step. And each step is a self-contained unit, easily and cheaply built into a ladder or stair. Let us send Catalog 3 A 15.

IRVING IRON WORKS CO.
LONG ISLAND CITY, N.Y., U.S.A.

Manufacturers of

IRVING SUBWAY TRADE MARK (PATENTED) REG. U.S. PAT. OFF.
THE FIREPROOF VENTILATING FLOORING

We Can Underbid Your Shovel Gangs



MECHANICAL HANDLING IN ALL LINES OF INDUSTRY

No matter how cheaply you can hire men, the work they can do in handling coal cannot begin to compete with that of

Gifford-Wood
Coal Handling Equipment

either in cost per ton, speed or convenience. Better put your problems up to our experts. Catalogue on request.

Gifford-Wood Co.
NEW YORK CHICAGO MAIN OFFICE AND WORKS HUDSON, N.Y. BOSTON BUFFALO

THE SCOOP CONVEYOR

THOUSANDS IN USE

FOR STORING AND RECLAIMING
LOADING AND UNLOADING
CARS, TRUCKS AND WAGONS

SAVES 6 TO 12 MEN
SAVES CAR DEMURRAGE

ELIMINATES SHOVEL AND WHEELBARROW WORK
KEEPS EQUIPMENT MOVING

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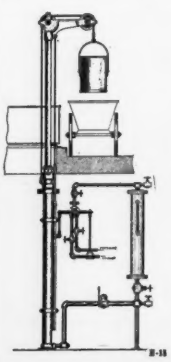
PORTABLE MACHINERY CO., PASSAIC N.J.



THE DEAN ASH HOISTS

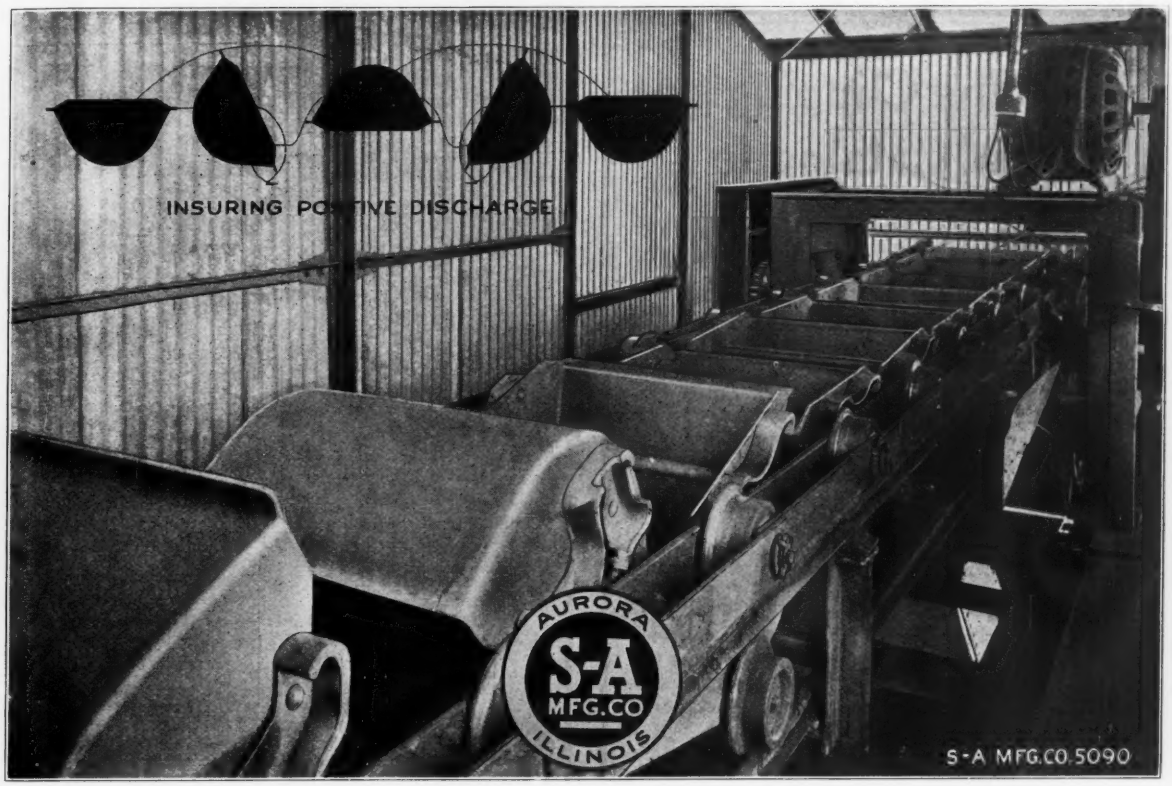
Designed to lift a can of ashes from the basement to a height of 6′ 6″ above the street, so that the cans may be emptied directly into the wagon.

Operates with steam, air or water at 70 lbs. pressure or more, or by electricity.

The piston is of polished steel tubing; the cylinder is of lap welded pipe. Mechanism is provided to retard the speed and stop the plunger at the extreme limit of the up and down strokes.

Send for Bulletin D-E.

WASHBURN & GRANGER, Inc.
50 Church Street New York, N. Y.



S-A
PIVOTED BUCKET
CARRIER
The conveyor that handles both coal and ashes in the power plant.

COMPLETE TURN-OVER DUMP

JUST one of the important exclusive features of the S-A Pivoted Bucket Carrier is the method of unloading materials from the buckets. In dumping, the bucket makes one complete revolution, effectively clearing the bucket of its entire load.

This is important where the material is sticky or where two different materials are carried at different times and any mixture is undesirable.

Three consecutive buckets are in some part of the dumping cycle at one time, yet the overturning is so accurately timed that the material is discharged within one-half the length of one bucket.

Send for Catalog No. 22-D.

We Also Build
Feeders
Pan Conveyors
Bucket Elevators
Screens
Skip Hoists
Car Pullers
Friction Hoists
Coal Crushers
Portable Conveyors
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STEPHENS-ADAMSON MFG. CO.

AURORA, ILLINOIS

Send The Clipping For New Catalogue

A thirty-six page book on boiler settings. True, it is about "Steel Mixture" boiler settings, but you probably know about the usual small-brick settings and you certainly want to know about the modern method—everybody keeps in step with the times.

"STEEL MIXTURE"

is a large-block construction for the Boiler Door Arches, Fire Box Linings, Back Combustion Chamber Arches, Blow-Off Pipe Protectors and Furnace Arches.

It is correctly designed; Front Arch to permit easy and quick firing; Fire Box Linings to be air-tight and save coal; Back Arch to be strong and gas-tight, and leave workroom underneath.

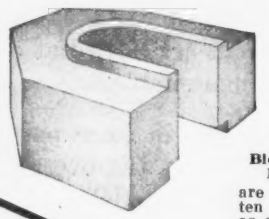
It saves money on repairs and replacements; gives continuous service and outwears at least two small-brick settings.

It is shipped promptly from stock; fitted up to the measurements of each individual setting. For all styles and sizes of boilers.

Send for this catalogue today.

McLeod & Henry Co.
Troy, N. Y.

New York
Boston
Detroit



Blow-Off Pipe Protectors are installed in ten minutes and as quickly taken down for inspection of pipe. Try a set of these as a starter at least.

McLeod & Henry Co.,
Troy, N. Y.

Gentlemen:

Please send your new catalogue on **"STEEL MIXTURE"** boiler settings.

Name .....

Address .....

PPE-74

When that arch burns out

Don't Shut Down

but while continuing to carry your load make quick temporary repairs with

PLIBRICO JOINTLESS FURNACE LINING

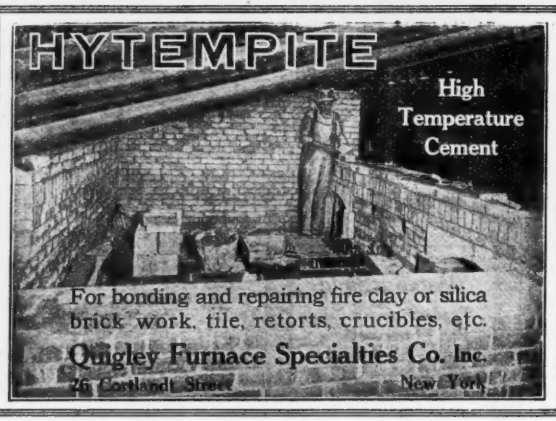
Then as soon as opportunity offers put in a complete PLIBRICO setting—front and back arches, baffles, side walls, bridge walls—and *you will need no further repairs.*

Send for our book F-42 on "Modern Furnace Building."

PLIBRICO is delivered only in steel containers of distinctive appearance as shown below.

Warehouse stocks in all principal cities

JOINTLESS FIRE BRICK CO.
1136 CLAY ST., CHICAGO, ILL.


HYTEMPITE
High Temperature Cement
For bonding and repairing fire clay or silica brick work, tile, retorts, crucibles, etc.
Quigley Furnace Specialties Co. Inc.
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JOHNS-MANVILLE SERVICE COVERS THE CONTINENT

Through—

Asbestos

JOHNS-MANVILLE
Serves in Conservation

—the Heat Retardant

SIL-O-CEL holds heat within the equipment, prevents its penetrating walls and shells and makes it more productive. Results can be measured instantly in lower fuel consumption, higher and more uniform temperatures, and increased capacity.

SIL-O-CEL is insulation, but more than insulation — a heat retardant effective at extremely high temperatures and at low. With a melting point of 2930° F., there is no shrinkage or settling at a direct heat of approximately 2000°. Furnished in brick, block, powder and cement form, adapted to every insulation requirement.

Full details contained in Bulletin J-6 A, sent free upon request.

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ELECTRIC FURNACE
"The World's Best Fire Clay Brick"

FOR BOILER SETTINGS

ELECTRIC FURNACE meet the requirements for a high-grade money-saving fire clay refractory better than any other brick manufactured.

Your copy of "Economy in Boiler Settings" will tell you why. Send for it.

CHICAGO FIRE BRICK COMPANY

MANUFACTURERS

133 West Washington St., Chicago, Ill.

Plants in Illinois, Indiana, Missouri, Ohio, Pennsylvania

1027

BETSON'S
REG. U.S. TRADE MARK PAT. OFF.
PLASTIC FIRE BRICK

is a splendid repair material for your present Boiler furnace linings, as well as the proper thing to use for front and back arches and gas-tight baffles. Used by thousands of plants with continued satisfaction. Any handy man can use it successfully.

Write for booklet that tells of its many uses in the boiler room

Betson Plastic Fire Brick Co., Inc.

P. O. Box 386-1, Rome, N. Y., U. S. A.

New York Office, 50-1 Church St.

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LIPTAK

Liptak Double Suspension Arch
Liptak Single Suspension Arch
Liptak Furnace Wall Support

If you are interested in reducing up-keep costs let us advise with you.

Write for detailed information.

Liptak Fire-Brick Arch Company

609 2nd Ave. So. Minneapolis, Minn.

Harbison-Walker Refractories Company

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Manufacturers of

Highest Grade Fire Brick
Boiler Settings a Specialty

Plants in Pennsylvania, Ohio, Kentucky, Indiana and Alabama

Kelly Grate Service is Fuel Saving Service

—also profit saving service and labor saving service firmly established during our 30 years of grate manufacturing experience.

Easy to Operate

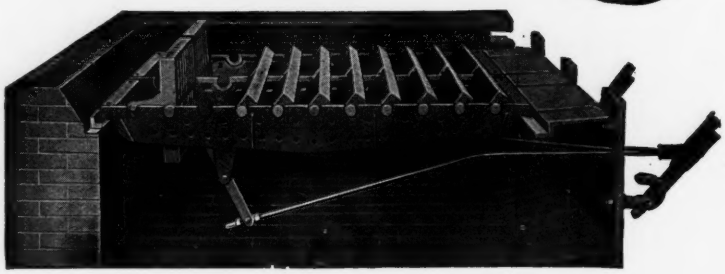
Easy to Install

The Kelly Rocking and Dumping Grate is a grate built of a mixture of iron that will withstand great heat. Its air openings are from ¼" to ¾" according to furnace requirements and fuel burned, and they are made to fit a furnace or fire box of any length and width.

By their use poor grades of coal produce good combustion and because not a particle of it is wasted less coal is used. Write for the other advantageous features of the Kelly Grate. They are given fully in our Catalog "C." Let us send you a copy.

KELLY GRATES GOSHEN IND.

When You Buy Kelly Grates You Buy Results

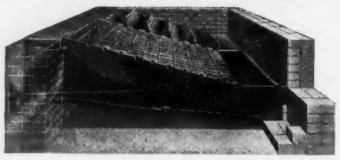


The Kelly Foundry & Machine Co., Goshen, Ind.

Established 1887 · POWER PLANT ENGINEERS · 617 Ninth Street

New York Office: 59 Park Place Chicago Office: 5 North La Salle Street

Steady Steam Pressure



great overload capacity, economy of fuel and smokeless fires are assured by installation of **Vogt Brothers Hand Stokers.**

Burn low grade fuels with high combustion efficiency. Air supply is **through** the fire. Sectional grate units easily removed, replaced and interchangeable. Sturdily built for durable service.

Write for catalogue.

VOGT BROTHERS MFG. CO.

(NATIONAL FOUNDRY & MACHINE CO.) INCORPORATED

LOUISVILLE, KENTUCKY

ORIGINAL HAND STOKER

HUBER HAND STOKER

PATENTED

Sole Manufacturers

FLYNN & EMRICH CO.

Established over 70 years

Baltimore, Maryland

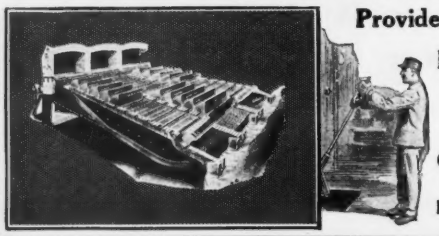
Files Stokers

Hand Operated

Write today for our Bulletin J.

The Files Engineering Co., Ltd.

Providence, R. I.



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We are miners and shippers of Crude Asbestos in any quantity. We produce all grades at our world-famous BELL ASBESTOS MINES in Canada. We also card fibres, spin yarns, weave cloths and make all sorts of Asbestos products.

For anything you want in Asbestos, turn to

Keasbey & Mattison Company

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Owners of the World's Largest Asbestos Mines

PULVERIZED COAL EQUIPMENT

FULLER-LEHIGH Pulverizers, Crushers, Dryers, Furnace Feeders, and Burners, insure maximum economy in fuel utilization.

BULLETIN 600A contains the latest information on Pulverized Coal for Boilers. We will mail you a copy with pleasure.

FULLER-LEHIGH COMPANY
FULLERTON, PA., U.S.A.

THE SAVING PRINCIPLE
of the
CANTON Rocking and Dumping Grate

does more than save coal; it also enables you to burn the **poorest kind of coal.** The Canton Grate makes for perfect combustion, clean, even fires and prolongs the life of the boiler. Absolutely guaranteed.

Canton Grate Company
1713 Dillon Place, N. E. and W. & L. E. R. R. Canton, Ohio

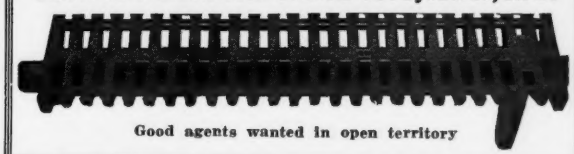
Write for literature.
Our price will interest you.

Durability, Strength and Simplicity
give
HERRICK Shaking Grates

a reputation which makes repeat orders in the same locality easy. Installation is very simple. The fuel, labor and repairs they save should not be overlooked.

Write for information and booklet "A Grate Proposition"

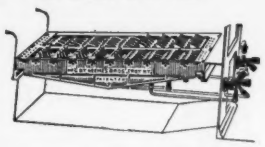
GEORGE S. HERRICK GRATE CO. Syracuse, N. Y.



Good agents wanted in open territory

"Fits My Idea of Great Efficiency"
That's what you'll say after you know the facts about a
NEEMES GRATE

Highly efficient because it makes for more perfect combustion of every pound of coal fed to it, thus permitting better results from cheaper coal and also a reduction in the amount of fuel used. Shakes out the ashes; cuts out the clinkers; dumps the fire. Write today for full particulars.



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MANUFACTURERS OF ROUND AND SQUARE GRATES

W. B. Connor, Inc., 90 West St., New York, N. Y.
Pralatt Equipment Co., Drexel Bldg., Philadelphia, Pa.
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Commutators Resurfaced *with* Motors *or* Generators Under Full Load

Sparking means power loss, but shutting down motors to resurface commutators means ***service loss***—worse still. Neither loss is necessary when you use—

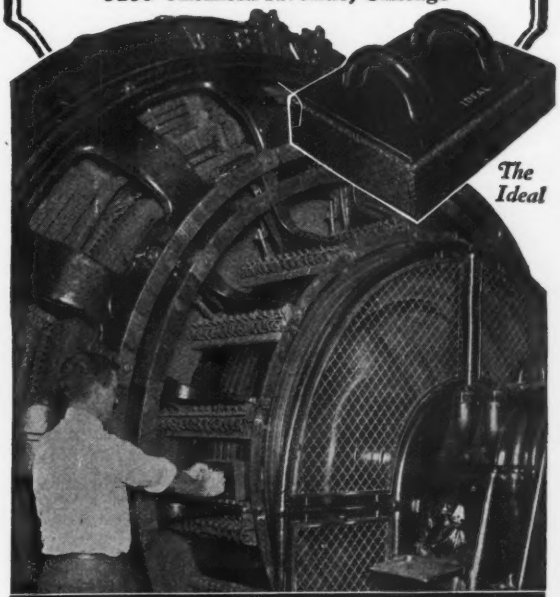
The IDEAL COMMUTATOR RESURFACER

No more turning down commutators in lathes—no more prolonged periods when commutators ***need*** resurfacing, but are not resurfaced. It's so easy to grind out the grooves with the Ideal in a few minutes that one man keeps commutators and collector rings in perfect condition by merely using the Ideal in his spare time.

Remember, the Ideal is ***not*** a natural stone, but a manufactured abrasive block of uniform cutting properties, non-metallic, of course, so it won't fill up, wear smooth or cause short circuits. Lasts longer, and never fails to take hold immediately on any commutator surface.

Take advantage of the liberal *free trial* offer below. Find out why so many prominent concerns swear by the Ideal.

IDEAL COMMUTATOR DRESSER CO.
3233 Sheffield Avenue, Chicago



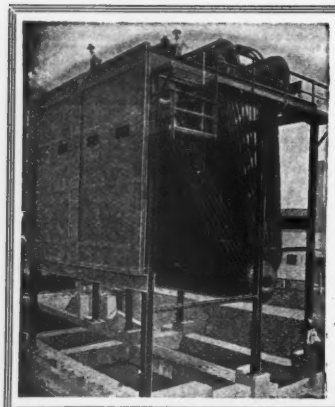
The Ideal

Send Coupon For Free Trial

IDEAL COMMUTATOR DRESSER CO. PPE 12-15-21
3233 Sheffield Avenue, Chicago

Gentlemen: Please send me an Ideal Commutator Resurfacer for free trial. If I like it I'll pay for it. If I don't like it, I will return it—the trial will have cost me nothing. I want to use it on equipment with approximate r. p. m., width, diameter and clearance as follows:

Approx. R. P. M.....Diameter of Commutator or Ring.....
Approx. width of Commutator or Ring surface.....
Approx. distance between brush sets.....Condition.....
Collector Ring or Commutator Material.....
My name is.....Position.....
Company.....Company address.....
City.....State.....



Connelly (Patented) Water Tube Boilers

are of the 4 drum type, have 100% tube area in the path of the circulation, and deliver steam superheated 5 to 10°

Simple in design, have no flat surfaces, no stay bolts, no crown bars or braces and free from hundreds of joints—no handholes.

Easily accessible for cleaning internally and externally.

Can be built in units up to about 4000 H. P. and 300 lbs. pressure.

Write for Our New Catalog, Desk 7

The D. Connelly Boiler Company, Cleveland, Ohio

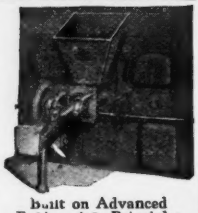
Founded in 1875 by Daniel Connelly

Detroit Underfeed Stokers

FOR EVERY SERVICE

There is a Detroit Stoker for every service—V-type Overfeed for natural draft—Single Retort Underfeed for forced draft with boilers developing up to 300 or 400 HP.—Multiple Retort Underfeed for forced draft large boilers. Twenty years of successful stoker building assures the best design and construction for each class of equipment. Ask for Folder 124.

DETROIT STOKER COMPANY
Detroit, Michigan



Built on Advanced Engineering Principles

Save fuel and labor

Frederick Underfeed Stokers Steam Jet Ash Conveyors

The Frederick Engineering Co.
Frederick, Maryland, U.S.A.
Main Sales Office 61 Broadway New York

FOSTER SUPERHEATERS

A necessity for turbine protection, engine cylinder economy, and utilization of superheat for all its benefits

Power Specialty Company Boston Philadelphia Pittsburgh Dallas Chicago San Francisco Kansas City London, Eng. **111 Broadway, New York**

WE-FU-GO WATER AND SCAIFE

PURIFICATION SYSTEMS
SOFTENING & FILTRATION
FOR BOILER FEED AND
ALL INDUSTRIAL USES

WM. B. SCAIFE & SONS CO. PITTSBURGH, PA.

Sturtevant
(REG. U. S. PAT. OFF.)

Fuel Economizers

are paying for themselves over and over again by their saving in fuel bills. All metal to metal joints make their maintenance extremely small and assure satisfactory operation.

They increase the capacity and prolong the life of your boilers.

Write for suggestions and catalog.

B. F. STURTEVANT CO.
Hyde Park, Boston, Mass.
and all principal cities.

For Moderate Vacuum Use

In numerous industrial operations the application of the

EYNON-EVANS Steam Jet Exhauster

has proved much more economical and efficient than a steam pump.

They produce the vacuum necessary for the priming of centrifugal pumps, or suction lines.

Write for catalog 16.

Eynon-Evans Corporation
1524 Clearfield St. Philadelphia, Pa.

McCLAVE COMBUSTION SYSTEMS

Are Cutting Down Power Cost in Modern Plants

In one of the large hotels in a Pennsylvania city, a battery of five McClave Semi-Automatic Stokers, Type "MA," with Argand Blowers paid for themselves in nine months.

These five stokers were under five 300 H. P. boilers and were installed to provide better combustion, and, at the same time, to permit the use of cheaper grades of coal.

The remarkable thing is that this saving of thousands of dollars was made in so short a time when but 50c a ton was saved on the different grades of fuel. It is evident from this and from the fact that the boilers were operated almost continuously at 200% of their rating that complete combustion must have been secured.

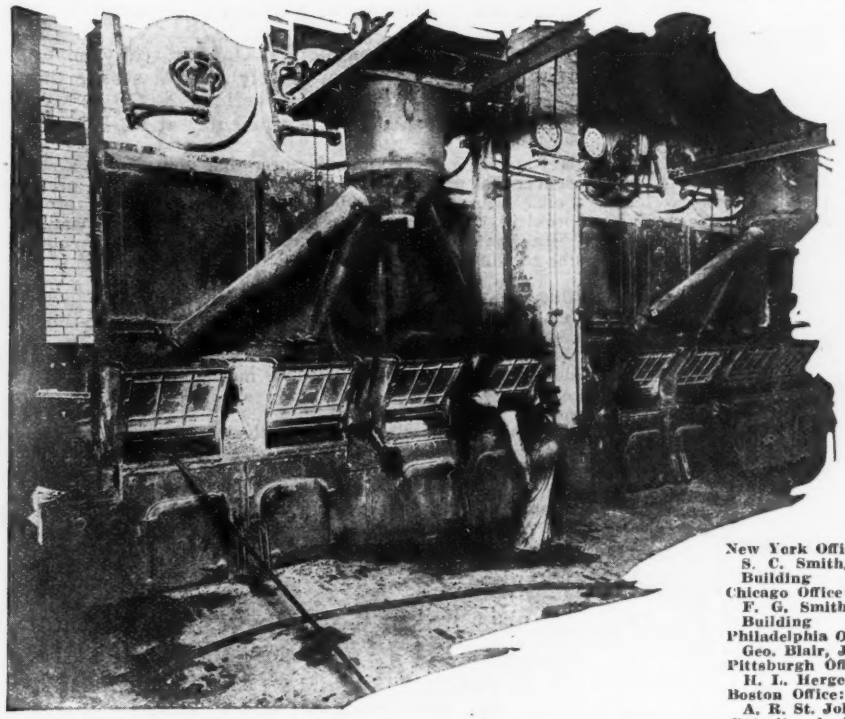
Another interesting point—maintenance for the last two-year period of a total of seven years of operation amounted to but 30c per horsepower. During the preceding five years, it was even lower.

Such figures are the result of furnishing the right system for the fuel to be used, plus equipment designed and built in every minute detail to perform the service for which it is intended.

McCLAVE-BROOKS COMPANY

Makers of the famous McClave Grates since 1883

Scranton, Pennsylvania



Four of the twelve McClave Semi-Automatic Stokers, Type "MA," installed in the boiler room of one of the largest hotels in New York City. McClave Stokers are doing excellent work in large hotels, office buildings and institutions. McClave Stokers are made in different types from hand-fired to full automatic to fit all requirements.

New York Office:
S. C. Smith, Mgr. 1302 Printing Crafts Building
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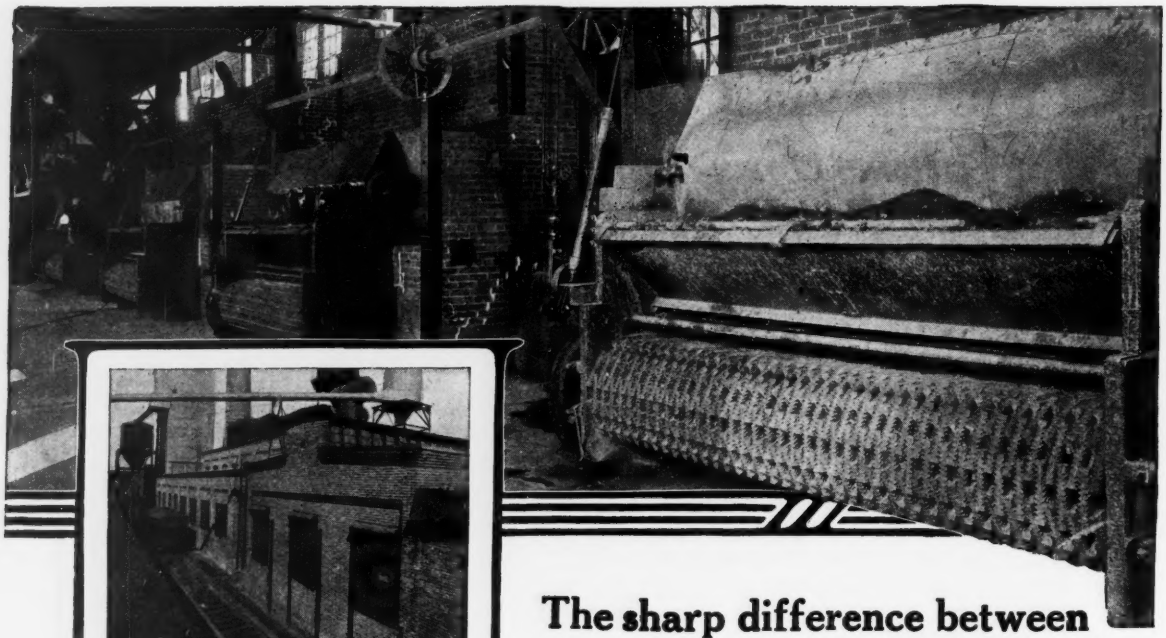
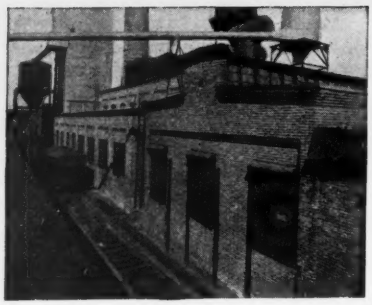
McClave COMBUSTION SYSTEMS *for greater economy*





Exterior of power plant Olds Motor Works, Lansing, Michigan. Above: interior.

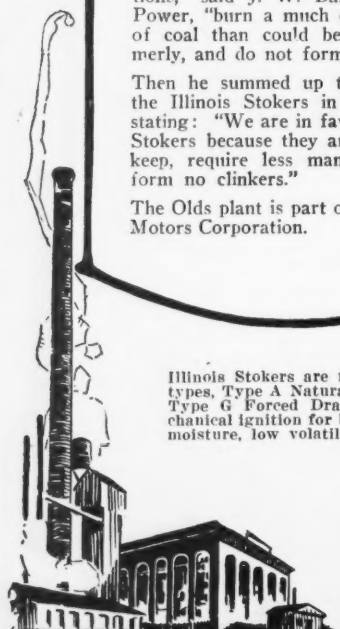
At the Olds Motor Works—

four Illinois stokers (natural draft) installed under 500 hp. boilers are meeting the load demands of this rapidly growing plant.

"They respond readily to load fluctuations," said J. W. Bailey, Supt. of Power, "burn a much cheaper grade of coal than could be burned formerly, and do not form clinkers."

Then he summed up the record of the Illinois Stokers in his plant by stating: "We are in favor of Illinois Stokers because they are low in upkeep, require less man power, and form no clinkers."

The Olds plant is part of the General Motors Corporation.



Illinois Stokers are made in two types, Type A Natural Draft, and Type G Forced Draft with mechanical ignition for burning high moisture, low volatile coals.

The sharp difference between "capacity" and "flexibility"

"WILL the ———— Stoker give us the boiler capacity we require?" you ask—at least that question is asked by almost every engineer who contemplates the installation of mechanical stokers.

Is your question complete? Does it really cover your requirements? Do you merely need a stoker that will carry your peak loads and overloads? Or do you need a stoker that will operate efficiently at ALL loads?

If you told a stoker manufacturer that you wanted a stoker to deliver 200 per cent of boiler rating—and only 200 per cent of boiler rating—you would have a definite "capacity" problem—a problem that could be easily solved by merely installing the right amount of grate surface and the correct air regulation for the combustion rate necessary to develop the specified rating.

But such conditions never arise in actual practice—a fact that has been fully recognized in the design of Illinois Stokers.

Both types (Type A, Natural Draft, and Type G, Forced Draft) have been developed to produce maximum economy of fuel at ALL loads.

This is made possible by the unrivaled Illinois system of Dampered Air Control, whereby the size of the fire rather than the combustion rate is reduced and increased as the load fluctuates.

Would you like to have a complete explanation of the sharp difference between mere capacity and real FLEXIBILITY as covered by the Illinois catalog?
Write.

Illinois Stoker Co., 106 W. 7th St., Alton, Ill.

Chicago: Ernest E. Lee Co., 115 S. Dearborn St.
Kansas City: J. F. Pritchard & Co., 419 Reliance Bldg.
Louisville: W. R. Wood, 601 Lincoln Bldg.

ILLINOIS STOKERS
CHAIN GRATE With Dampered AIR CONTROL

Repeat Orders

A big steel mill grew and as they grew they needed power and as they added to their power plant they installed stokers.

1st Order, 2 Type E Stokers
2nd Order, 4 Coxe Stokers
3rd Order, 3 Type E Stokers
4th Order, 8 Type E Stokers
5th Order, 2 Coxe Stokers
6th Order, 1 Type E Stoker

Steel is the barometer of business, management is keen, and the advantage of dealing with an organization that supplies equipment for any given condition is recognized. For instance this company has installed Type E Stokers to burn Bituminous coal—Coxe Stokers to burn Coke Breeze.

International Combustion Engineering Corporation

COMBUSTION ENGINEERING CORPORATION

COMBUSTION ENGINEERING BUILDING
BROAD STREET, NEW YORK

Type E Stokers—for Bituminous Coal Lopulco Pulverized Fuel Systems The Grieve Grate—Hand-Firing
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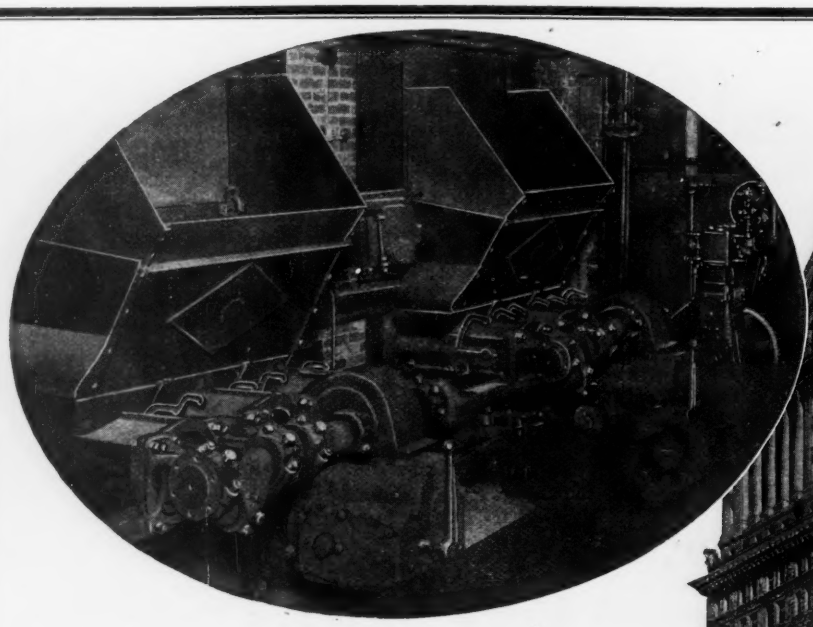

Riley Stokers---Union Central Life Insurance Bldg.

Cincinnati, Ohio

The Union Central Life Insurance Building is the tallest office building west of New York City. It towers 495 ft. above the street level and contains 8 acres of floor space.

Speaking of the

RILEY UNDERFEED STOKERS

installed here the Manager of this building states:

"The Riley Stokers installed in our boiler room have been giving us complete satisfaction, and have been in almost continuous operation since their installation."

Riley Stokers are particularly adapted where elimination of smoke is a necessity. The *moving grates* keep the fuel bed even, active and porous, allowing an intimate mixture with air at all times. The hydrocarbon gases after being distilled in the retorts pass up through an active body of burning coke, then through the fire zone, passing off as invisible, completely burned gases.

Ask for our Catalog PE-12 describing the Riley Underfeed Stoker in full

The Sanford Riley Stoker Company is now prepared to equip new Riley Stokers with coal agitators licensed under the Negus-Tiffany patents.

"A type to meet every stoker need"

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Ten Points *of* JONES Superiority

Simplicity
Minimum of moving parts. Simple dumping mechanism. Simplest high-duty stoker.

Low Maintenance
No moving parts in fire. Tuyere blocks always covered by green fuel, minimizing replacements. No shearing pins to fail and cause breakage. Unequaled accessibility.

High Efficiency
Scientific application of the under-feed principle, first made successful in the Jones.

Automatic Cleaning
Thorough burning of fuel. Travel of fuel bed is mechanical—not a gravity movement.

Prevention of Smoke
Combustion is so complete that there is no smoke.

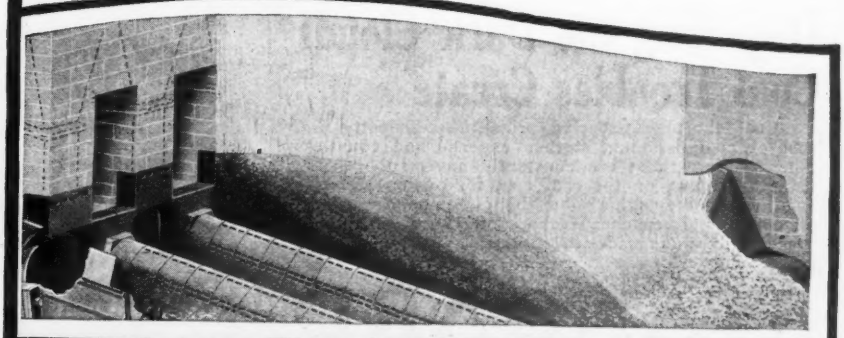
Prevention of Clinkers
on side and Bridge Walls—due to design of tuyeres, absence of gravity movement, and "Automatic Cleaning" feature.

Heavy Overload Capacity
results from the perfect fuel bed, and responsive control of fuel and air.

Minimum of Moving Parts
reducing maintenance.

Individual Control of Retorts
producing an excellent fire at all times.

Automatic Control of Fuel and Air
insuring even steam pressure regardless of load fluctuations.



A Smokeless Chimney Always —Even Where Loads Fluctuate and Coal Varies

THE first Jones Stoker ever built—it was also the first under-feed stoker ever built—produced no smoke! This result was entirely unexpected by the inventor, proving that smokeless operation is an inherent feature of the under-feed principle of combustion.

Unless the volatile gases released from bituminous coal are mixed with the proper amount of air and kept at high temperature combustion is not complete and smoke is formed. Smoke once formed cannot, from a practical standpoint, be consumed; it must therefore be prevented.

In the Jones "A-C" stoker the volatiles are slowly and thoroughly driven off during the steady progress of the fuel bed through the extra long retorts. These volatiles are automatically supplied with just the amount of air for complete—and consequently smokeless—combustion. The coal from which volatiles are released is completely coked, and of course burns without forming smoke—a characteristic of burning coke.

There is no possibility of holes in fire, avalanching, or slipping, so no smoke is formed even at heaviest overloads. Where combustion arches are used smokeless combustion with all fuels at all loads is next to impossible.

The new booklet, "Ten Points of Jones Superiority," covers the ten major betterments of the Jones "A-C" (listed opposite). Where shall we mail your copy?

Jones "A-C"
Automatic-Cleaning Automatically-Controlled High-Duty Stoker

The Under-Feed Stoker Co. of America
General Offices: Book Building, Detroit

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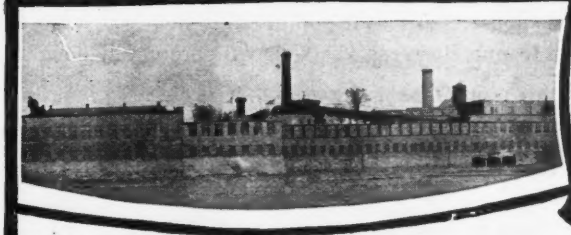
The Under-Feed Stoker Co., *of Canada, Ltd.*
81 Victoria Street, Toronto

Sole manufacturers in the United States and Canada of the Jones Under-Feed Stoker



Above: This Jones owner takes no chances in calling attention to his "smoke-less chimney." Opposite: An unretouched photograph showing an interesting contrast. Note the smokeless Jones Chimney at the right.

Dispelling the Dark Clouds Coal Troubles Create

Coal shortages, soaring prices, the difficulty and cost of coal handling, storage expense and countless other shadows, that are constantly hovering over the plant depending on the coal man for power, are zero quantities in the engine room that is equipped with fuel oil engines. Even cheap grades of oil can be utilized successfully and made to produce the maximum of power with

STANDARD Diesel Engines

They are suitable for any power purpose and are especially adapted for use where close regulation is necessary. Built in both vertical and horizontal types.

Their ruggedness and simplicity both appeal to engine users who demand durability and maximum engine efficiency.

Working parts are few, very accessible and strong, requiring an almost negligible amount of attention.

No ignition apparatus is needed. Acts automatically, operating on the Diesel principle. Starts up immediately with no delays.

Our catalog will tell you more of its operation and construction. Let us send you a copy.

The Standard Diesel Engine

Built by the
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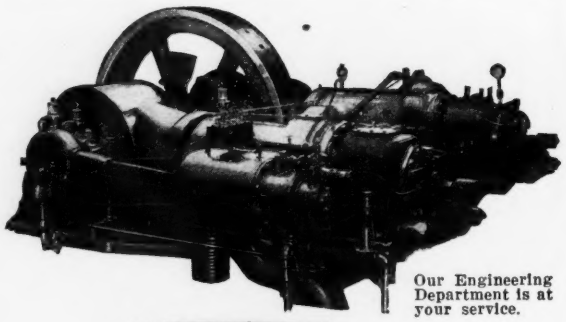

Our Engineering Department is at your service.

It's Good Business

Preventing human beings from suffering, injury and death is humanitarian, but it is also the best kind of good business.

The Safety Section of the United States Railroad Administration reports for 1919 an actual saving of $4,000,000 through accident reduction by safety work; and the United States Shipbuilding Board, a saving of $10,800,000 for the same period. Of course, these are gigantic enterprises, but the results also are gigantic and, after all, were accomplished by the individual efforts of hundreds of member plants of these industries.

Your plant is a member plant of your industry. Are your savings through Accident Prevention as large as they should be? Would a 75 per cent reduction of your accidents interest you?

The National Safety Council can help you to effect this 75 per cent reduction. It offers to you all of the accumulated accident prevention experience of America, and the only organized accident prevention service in existence which has demonstrated that it cannot fail to help you.

A letter to our Business Division will bring full details of membership and service.

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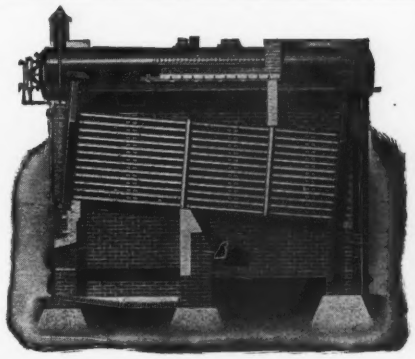

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Steel Throughout
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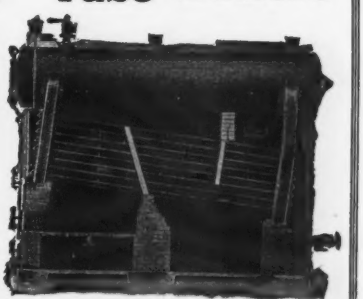

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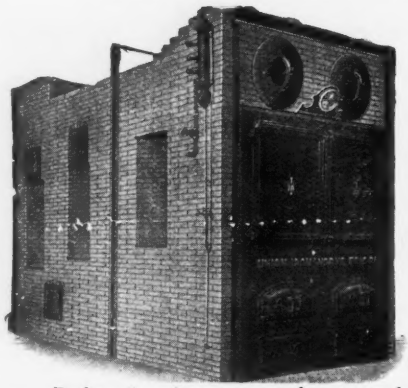

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You find it in the Union Water Tube Boiler with its unrestricted circulation, its patented purifier that eliminates deposits **before** the feed water comes in contact with the heating surfaces; its patented corrugated flange connection between drums and headers that does away with internal strains and leaks, its steel hand-hole plates, removable through hole each covers, its horizontal drums, insuring ample liberating surface, dry steam, and great water storage capacity; and the excellence of its workmanship.

And the Union Water Tube Boiler is safe, due principally to our patented corrugated flange connection which makes impossible the fault of restricted circulation, and avoids a multiplicity of elements often a source of trouble.

Before leaving our works every boiler is tested under steam after the usual hydrostatic test has been applied.

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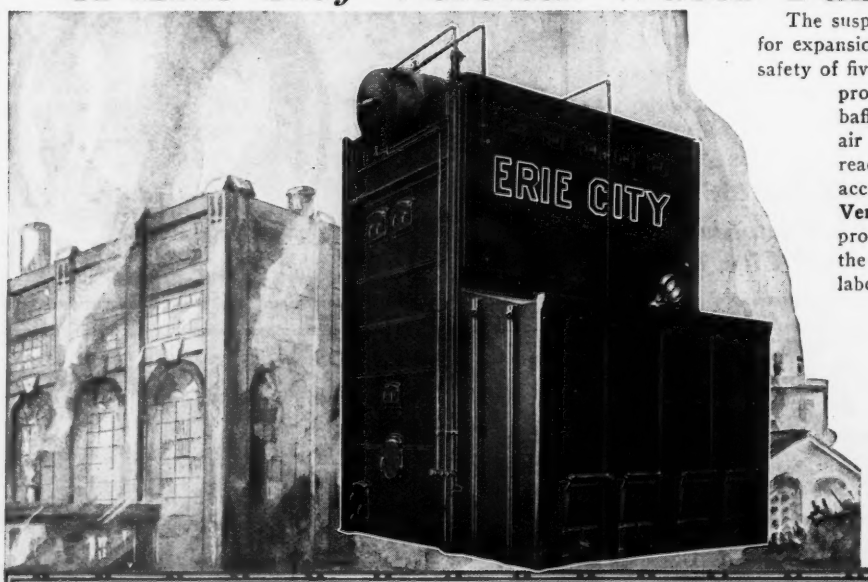
Union Water Tube Boiler

Many Features Which Add to the High Efficiency of Erie City Vertical Water Tube Boilers



The suspended lower drum which allows for expansion and contraction, the factor of safety of five, the ample grate surface which provides for utilizing cheaper fuels, baffling and arch construction, the air tight settings, provision for ready inspection and easy cleaning account for the record of **Erie City Vertical Water Tube Boilers** for producing the most **dry** steam for the least expenditure of fuel and labor.

These and other reasons why successful plants the world over specify **Erie City Boilers** will be found in our catalog. Write for a copy or consult our sales engineers located in all principal power centers of the world.

We are makers of Vertical and Horizontal Water Tube Boilers; Horizontal Tubular and "Economic" Boilers and Lentz Engines

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IN WATER TUBE BOILERS

The baffles in SPRINGFIELD BOILERS are of special design. Each section of the boiler is provided with its own baffle extending the full height of the section; when the boiler is assembled, the baffles form a solid—absolutely tight wall.

This is due to the fact that they are composed of cast iron shells filled with refractory material which forms the face of the baffle presented to the products of combustion. When in place, they are tight, immovable and practically indestructible.

The tubes pass through sleeves in the baffles and any tube may be removed or replaced without disturbing any other tube or other part of the boiler.

There are no baffle tile to melt and fuse to the tubes—pulling out when a tube is removed. Should any of the refractory material come out of the baffle it is as easily replaced as is a tile in any other boiler.

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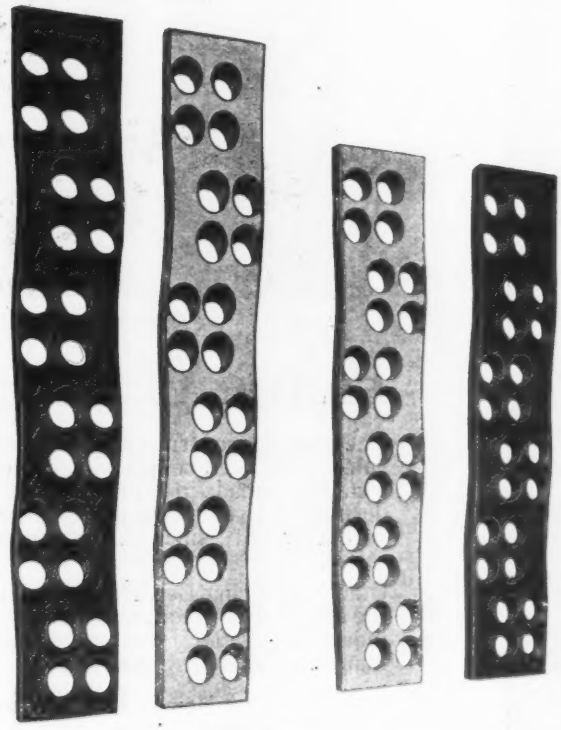

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A Heine Waste-Heat Boiler in process of installation

Heine Waste-Heat Boilers

The present modern practice of utililizing waste-heat gases at high velocity in steam boilers was instituted as a result of a Heine boiler installation made in 1910. The gas velocity then established as most desirable is even to this day considered the best practice, although experiments have since been made with velocities over a much wider range.

Our Engineering Department has had long and varied experience in the design and erection of waste-heat boiler plants and can answer inquiries in detail if you will supply information regarding the raw materials, fuel, operating characteristics of the primary furnace, etc.

A Heine waste-heat boiler installation can save its own cost in a few years' time.

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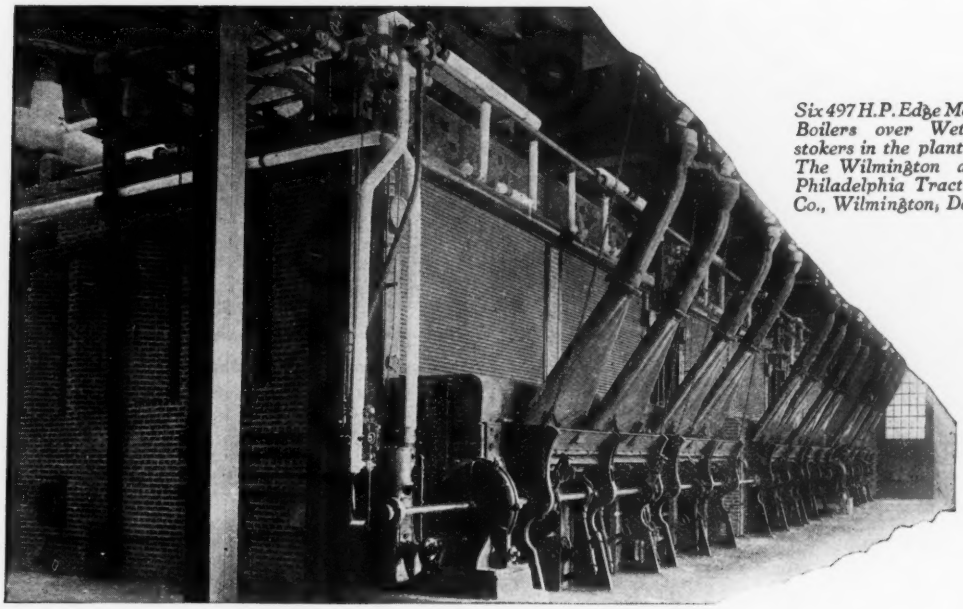

Six 497 H.P. Edge Moor Boilers over Wetzel stokers in the plant of The Wilmington and Philadelphia Traction Co., Wilmington, Del.

Can your boiler room strengthen your profit margin?

WHERE manufacturing costs are excessive, a large part of the blame can generally be traced to the boiler room. No other part of the average plant offers such opportunities to improve methods and equipment, increase efficiency, and effect substantial savings at so small a cost.

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Edge Moor Water Tube Boilers are designed to convert the highest possible number of heat units in each ton of coal into usable power. Many plant owners have found it highly profitable to replace their old, inefficient boilers with Edge Moors. Their record of savings extends over a period of several decades.

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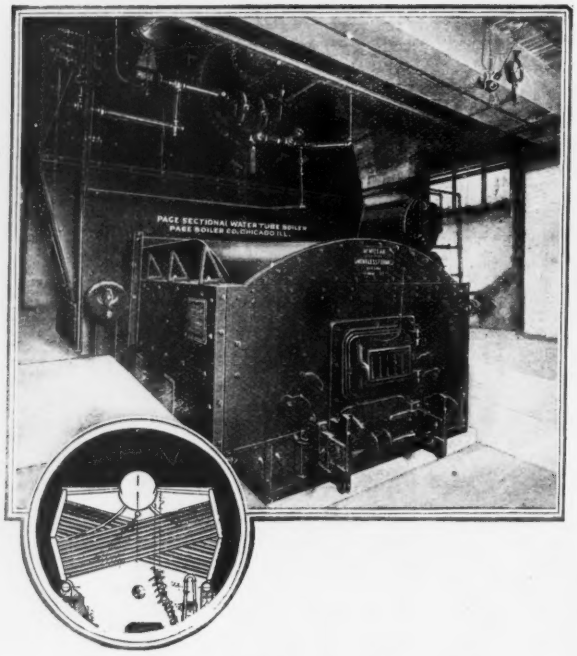

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A number of distinctive Page features are behind this exceptional performance. The criss-cross arrangement of the tubes assures a maximum of heating surface exposed to the furnace. The tubes are smaller than those used in boilers of equal capacity, which of course means greater tube surface per unit of contents.

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Page Boiler Company
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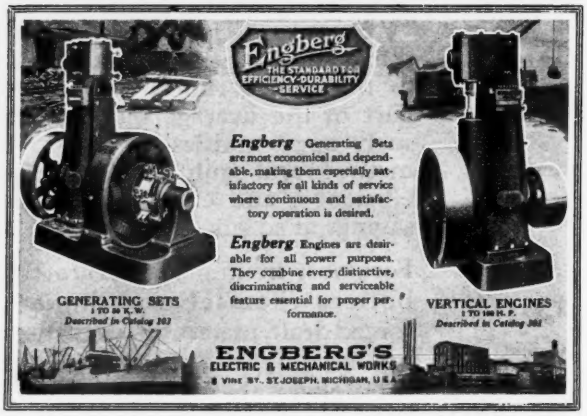
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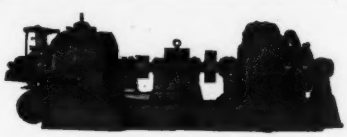

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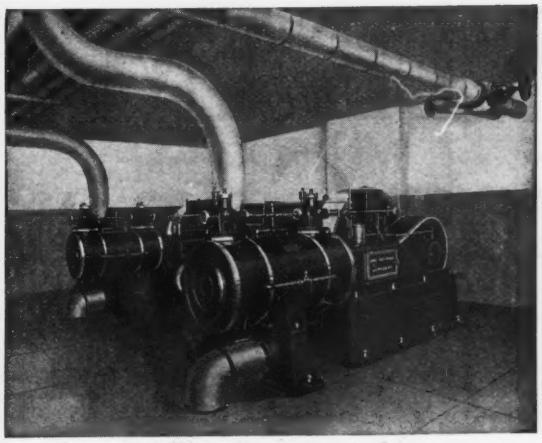

Ames Una-flow Engines in Office Building

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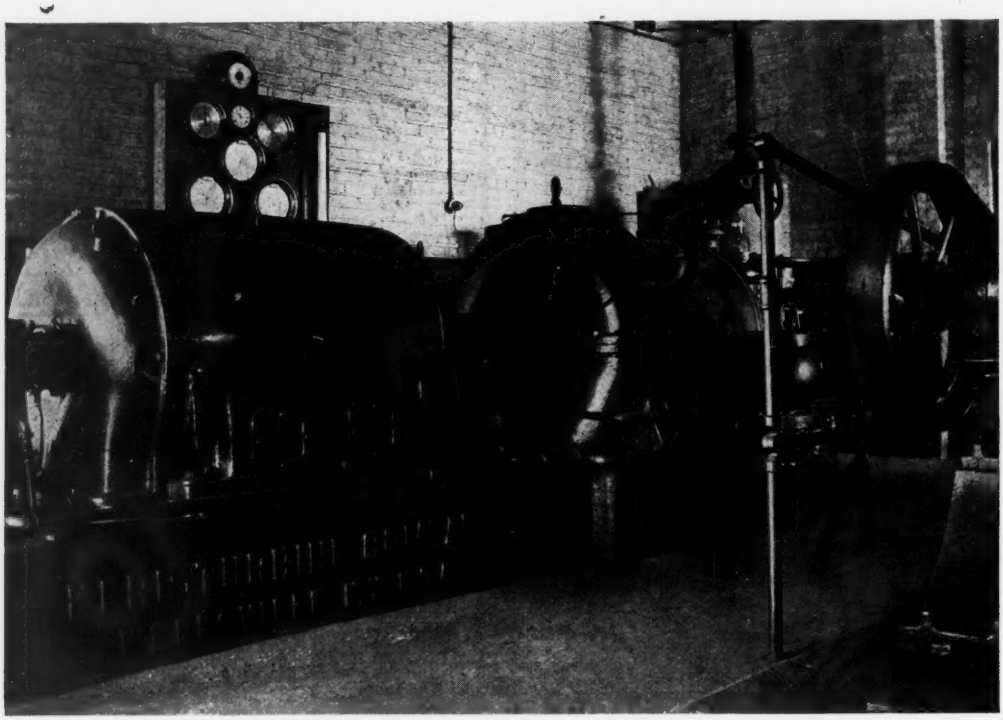

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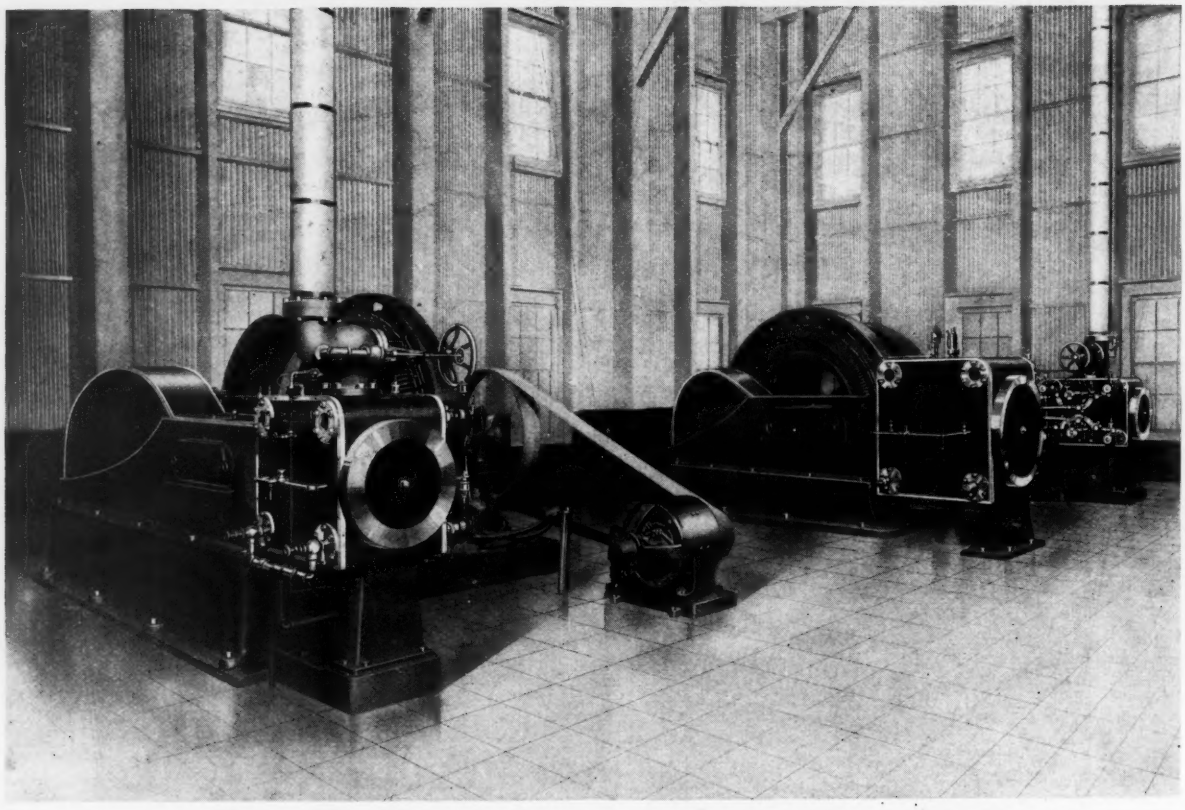

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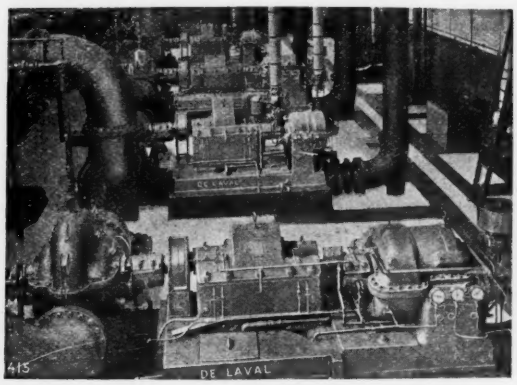

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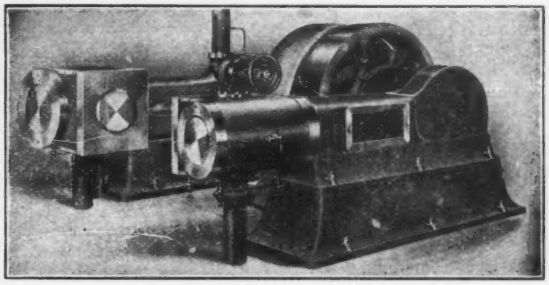

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